ICON
ARCHITECTURAL GROUP

Valley City Public Schools
New School
Valley City, North Dakota

PROJECT MANUAL
Volume 2 of 2

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Legend:

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END OF SECTION

SECTION 21 01 00 - FIRE PROTECTION GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 APPLICABILITY

A. This section applies to and forms a part of each of the sections of Division 21. This section, and each of the sections to which it applies, is subject to the requirements of the Instructions to Bidders, General Conditions, and Special Conditions of these complete specifications.

B. The work covered by this Division of the Specifications consists of furnishing all labor, supervision, equipment, materials, all incidentals, related items, and appurtenances, and performing all operations necessary to complete the installation of work in strict accordance with these specifications and drawings.

C. Only such items as are hereinafter specified or indicated on the drawings to be furnished by others, shall be considered to be furnished by others. All other items are to be considered as a part of this Contract and shall be so bid.

D. The omission of specific reference to any parts necessary to, or reasonably incidental to, a complete installation shall not be construed as releasing the Contractor from furnishing and installing same.

E. All work shall be finished, tested and ready for operation.

1.2 DEFINITIONS

A. Word "Furnish" where written in Division 21 specifications and drawings shall mean Contractor shall deliver to the site item(s) specified, as well as additional specialized materials and/or accessories necessary for the use and operation of item or items specified.

B. Word "Install" where written in Division 21 specifications and drawings shall mean Contractor shall set in position, connect (including sub-assemblies furnished), and adjust for use. Contractor shall furnish miscellaneous specialty items such as hangers, valves, unions, piping, sheet metal, etc., as obviously necessary for a complete and operating installation.

C. Word "Material" where written in Division 21 specifications and drawings shall mean any and all apparatus, equipment, devices, fixtures, components, products, assemblies, items, parts, things, and any other pieces specified or shown or required.

D. Word "Labor" where written in Division 21 specifications and drawings shall mean any and all physical effort, manpower, time, expertise, tools, equipment, and services to carefully assemble, install and affix all material in a proper, complete and acceptable manner.

E. Word "Provide" where written in Division 21 specifications and drawings shall mean "Mechanical Contractor shall furnish all labor and material and completely and properly install such material and leave same in acceptable condition and intended acceptable working order".

1.3 DISCREPANCIES OR OMISSIONS FROM DRAWINGS OR DOCUMENTS

A. Notify the Engineer of any discrepancies in, or omissions from the drawings or documents. Neither the Owner nor the Architect will be responsible for any oral instructions or modifications of the specifications or drawings. Written interpretations will be made only by Addenda.

B. If discrepancies are not reported, the contractor shall bid the greater quantity or better quality (highest dollar value), and appropriate adjustment will be made after contract award.

C. Discrepancies discovered during construction shall immediately be called to the attention of the Architect/Engineer for clarification.

D. All minor items necessary for the completion and successful operation of the system, whether or not herein definitely specified or indicated on the drawings, shall be furnished, and installed.

E. Omission of/or express reference to any material necessary for/or reasonably incidental to complete installation shall not release Contractor from providing such material. Where material is shown on drawings but is not specified or is specified but not shown, such material shall be considered both shown and specified.

F. Any work not clear to Contractor shall be referred to Engineer for clarification before bid is submitted. If no question is raised prior to opening of bid, Contractor shall be required to provide work in question as directed by Engineer, whose decision is final, without additional charges.

G. By virtue of submitting a bid, Contractor agrees that he is skilled and experienced in use of and in interpretation of drawings and specifications. Contractor further agrees that he has carefully reviewed all drawings, all specifications, and all addenda, which constitute bid documents for this contract, and finds them free of ambiguities and good and sufficient for bidding and construction purposes.

1.4 **DRAWINGS**

A. The drawings indicate the extent and general layout of the mechanical systems intended for the building. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, connections, and accessories which may be required. Furnish offsets, fittings, valves, and accessories as may be required, to produce a complete and operating installation of type shown and specified.

B. All piping shall be routed so as not to obstruct access to other equipment. Routing indicated on drawings is representative of intended location but shall be field verified. It shall be this contractor’s responsibility to coordinate with other trades for accessibility.

C. Any work or system on the roof not explicitly indicated on the roof plan shall be approved by the engineer prior to installing.

D. In general, the mechanical equipment drawings are drawn to scale as noted. Obtain dimensions and locations of partitions, walls, etc., from the Architectural drawings wherever possible and do not scale the mechanical drawings. Consult the Architectural drawings for details of construction, location of suspended ceilings, ceiling heights, and other pertinent information. Architect's drawings shall not take precedence over field measurements.

E. All drawings and specifications shall be considered in bidding. The drawings and specifications are complimentary, and what is called for in either of these shall be as binding as though called for by both. Should any conflict arise between drawings and specifications, such conflict shall be brought to the attention of the Architect.

1.5 SITE INSPECTION

A. Before submitting a proposal for the work contemplated in these specifications and accompanying drawings, each bidder shall examine the site and familiarize themselves with all the existing conditions and limitations, including the extent of demolition, cutting, and patching to be done by the Contractor for Mechanical Work. No extras will be allowed because of the Contractor's misunderstanding as to the amount of work involved, or his lack of knowledge of any condition in connection with the work.

1.6 **PRIOR APPROVAL REQUESTS**

A. Where the Bid Documents stipulate a particular Product, substitutions will be considered by the Engineer up to 10 days before receipt of bids.

B. The submission shall provide complete information, test, etc. relating to quality, performance, suitability, to determine acceptability of such products.

C. When a request to substitute a Product is made, the Engineer may approve the substitution and will issue an Addendum to known bidders.

D. Provide Products as specified unless substitutions are submitted in this manner and subsequently accepted.

E. The cost of any changes of other trades as a result of use of the substitution material or equipment must be borne by the Contractor submitting such material or equipment.

1.7 **REVIEW OF MECHANICAL MATERIALS AND EQUIPMENT**

A. Within thirty (30) days after award of construction contracts, Contractor shall submit for acceptance to the Architect quantity of shop drawings specified for the equipment indicated in these specifications. The shop drawings shall include the equipment manufacturer’s name and address, catalog designation or

model number, rough-in data & dimensions, performance curves and rated capacities & operational characteristics.

B. The Contractor shall thoroughly review each item for compliance with these Specifications making any necessary corrections prior to submittal. Each shop drawing set shall be stamped, signed, and dated indicating Contractor review and submitted electronically via PDF file format. The PDF file name shall include the relevant specification section number for reference. If the Contractor fails to properly review shop drawings, the Contractor shall reimburse the Engineer for all additional reviews on a time and material basis.

C. Provide samples of materials or equipment proposed to be furnished, if requested. Samples shall become the property of the Architect/Engineer and will be returned only when accompanied by a written request to do so.

D. None of the items listed shall be purchased, delivered to the site, or installed, until the item is reviewed. No substitution will be permitted after review except where such substitution is considered by the Architect to be in the best interest of the Owner.

E. The Engineer will review all Shop Drawings submitted and will retain a copy for record file.

F. Approval Stamp: This review is to verify general conformance with the design concept of the Project and substantial compliance with the information provided in the Contract Documents. This review does not in any way relieve the Contractor or their suppliers of their responsibility to provide all materials and equipment as specified, in quantities, quality and dimensions required. Submittals will be reviewed with the following actions:

1. "No Exception Noted" indicates that the Submittal appears to conform to the design concept of the Work and that the Contractor, at his discretion, may proceed with fabrication and/or procurement and installation.
2. "Make Corrections Noted" indicates that the Submittal, after noted corrections are made, appears to conform to the design concept of the Work and that the Contractor, at his discretion, may proceed with fabrication and/or procurement and installation, if the corrections are accepted by the Contractor without any increase in Contract Sum or Time.
3. "Revised and Resubmit" indicates that the noted revisions are such that a corrected copy of the Submittal is required for review to confirm that the noted revisions have been understood and made. The Contractor, at his discretion, may proceed with fabrication and/or procurement and installation after submitting a corrected copy and verifying with the reviewer that the corrected copy is acceptable, if the corrections are accepted by the Contractor without an increase in the Contract Sum or Time.
4. "Rejected" indicates that the Submittal does not appear to conform to the specifications, a resubmission is required, and fabrication or procurement is not authorized.

G. If the Engineer rejects (Revised and Resubmit or Rejected) the same section two times the engineer shall be compensated for additional reviews. Any subsequent submittal will require the inclusion of a check made out to the engineer in the amount of $ 500.00. Contractor is responsible for all delays caused by the resubmittal process.

H. Should the contractor fail to comply with any of the requirements of the preceding sub-paragraphs; then the right is reserved by the Architect to select any or all items in the material schedule, with that selection to be final and binding upon the contractor. The materials selected or reviewed, as the case may be, by the Architect, shall be used in the work at no additional cost to the Owner.

I. When the contractor chooses to furnish and reviewed material or equipment that requires electrical specifications/connections (circuit breaker, conduit, wire, labor, etc.) different than shown and/or scheduled on the drawings, or specified in detail, the contractor shall be responsible for coordinating any necessary changes and shall bear the cost of such changes (including engineering costs).

1.8 PROPOSAL REQUESTS AND INSTRUCTIONS

A. For any proposal request or instruction that requires an adjustment to the Contract Sum, submit an itemized quotation for the change(s) described in the proposed modifications to the Contract Documents. Proposal shall also indicate credits, deducts, and/or offsets for material and labor originally included in contract.

1. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. Breakdown shall include amounts, lengths, quantities, types, sizes, etc. of material.
2. Indicate applicable taxes, O&P, delivery charges, equipment rental, and other incidental charges.
3. Include costs of labor and supervision directly attributable to the change.
4. All sub-contractor pricing shall include the same breakdown as described above.

1.9 **warranty**

A. All equipment and installation shall be provided with a 1-year warranty beginning with substantial completion.

B. Refer to individual spec sections for specific warranty information that is different than stated above.

C. Submit warranty with related forms completed in Owner's name and registered with manufacturer.

1.10 **MANUALS**

A. In addition to catalog data and shop drawings submitted for review, this contractor shall furnish Operation and Maintenance Manuals for the mechanical systems. Manuals shall be delivered to the Architect before final observation of the work.

B. Operation and Maintenance Manuals shall be furnished in PDF electronic format as well as two (2) copies bound in new hard backed 3 ring binders with the title "Operations and Maintenance Manuals" and the project title clearly printed on the front cover and side of binder .

C. Provide an index at the beginning of the manual for the sections included in the manual.

D. All sections in hard copy manuals shall be referenced with plastic tabs.

E. Include at the front of the manual a complete listing of the Architect, Engineer and contractors and sub-contractors used on the project. Listing shall include names, addresses and phone numbers for each.

F. Manuals shall be arranged in order similar to the specifications. All major pieces of equipment shall be referenced with tabs. At the beginning of each section, the equipment supplier's name, address, and phone number shall be provided.

G. Data for equipment included in the manuals shall include:

1. Approved shop drawings clearly showing the models, sizes and capacities of equipment used.
2. Operations Manuals detailing step by step procedure to follow putting the equipment into operation.
3. Maintenance Manuals from the manufacturer of each piece of equipment including instructions on installation, maintenance, and lubrication. Manuals shall include parts lists for all replacement parts.

H. The following items shall also be included in the manuals for the Owners information: Certificate of tests performed on Fire Protection System as submitted to insurance company and Signed owner instruction forms for all items specified as requiring owners instruction.

I. Operations and Maintenance Manuals shall be submitted to the Engineer for approval prior to delivery to the Architect.

1.11 **INSTRUCTION OF OWNER'S EMPLOYEES**

A. Furnish, without additional expense to the Owner, the services of competent instructors, who will give full instructions in the care, adjustment, and operation of all parts of the mechanical equipment to the Owner's employees who are to have charge of the equipment.

B. An Operating and Maintenance Manual shall be made available to the Owner's operating personnel during the instruction and left with the Owner upon completion of the instruction.

C. The number of man hours of instruction furnished for each system shall be as specified in other sections of this specification. Hours of instruction shall be divided up into a minimum of two (2) instruction periods with 75% of time used for an initial instruction and 25% of time used for a follow up instruction, a minimum of four (4) weeks after initial instruction.

D. “Instruction of Owner's Employees" form at end of section shall be filled out and signed by Contractor and Owner's Representative and three (3) signed copies of form sent to Engineer.

E. Owner training and instructions:

1. Sprinkler system including but not limited to piping, heads, alarms, etc. shall not be less than four (4) man hours.

1.12 INSTALLATION OF EQUIPMENT

A. All equipment shall be installed and connected in accordance with manufacturer's instructions and recommendations unless such instructions are in conflict with these specifications. Auxiliary piping, valves, electrical connections, etc., recommended by the manufacturer or required for proper operation shall be furnished and installed complete.

B. All equipment shall be installed in such a manner and location as to facilitate accessibility for maintenance and/or replacement.

1.13 RECORD DRAWING

A. The contractor shall maintain one set of drawings at the job site used as a master copy. Each change order or other revision, deletion, or addition shall be clearly marked and noted by colored pencil. This copy of plans shall be furnished to the Architect upon completion of the project.

B. The contractor shall note on the record drawings the elevations and/or inverts of water service where it exits the building foundation.

C. A complete set of these drawings shall be scanned at a resolution of 600dpi in color and saved in an Adobe PDF portfolio format with index to each sheet by name and burned to a non-volatile media. The electronic copy of the as-built drawings shall be transmitted to the Engineer. After review and approval by the Engineer, the as-built drawings will be turned over to the Owner.

1.14 COOPERATION WITH OTHER TRADES

A. Cooperate with other trades so as to avoid interferences. Where required to avoid interferences with other work or to increase the headroom. Carefully check all construction details to assure the proper installation of all work under this specification. Schedule the work such that it will keep pace with the work of other crafts and cause no delay.

1.15 INSPECTION OF SITE

A. Before submitting a proposal on the work contemplated in these specifications and accompanying drawings, each bidder shall examine the site and familiarize themself with all of the existing conditions and limitations. No extras will be allowed because of Contractor's misunderstanding as to the amount of work involved or lack of his knowledge of any condition in connection with the new construction.

1.16 PAVEMENT, CURB AND SIDEWALK REPLACEMENT

A. This Contractor shall be responsible for replacement of existing street pavement, curbs, and sidewalks, etc., removed or damaged by them during the course of the work, unless such pavement, curbs, sidewalks are to be constructed under the General Contract. The work shall be done in accordance with local requirements.

1.17 CODES, ORDINANCES, REGULATIONS & STANDARDS

A. The entire installation shall be made in accordance with all state and local laws. If, in any instance, the plans and specifications conflict with such laws, the law shall take precedence. This, however, shall not be construed as relieving the contractor from complying with any requirements of the drawings and specifications that may be in excess of the rules and not contrary to the same.

B. All work shall conform to applicable state and local codes, ordinances, regulations and/or standards.

1.18 **PERMITS AND LICENSES**

A. This contractor shall obtain and pay for all licenses and permits and shall pay for all fees and charges for the connection to outside services and use of property other than the site of the work for storage of materials or other purposes.

B. Contractor shall coordinate and request all inspections from authority having jurisdiction. The Contractor shall notify the Architect of all such coordinated inspections (date & time) and shall submit certificates of inspection and final approval of the local inspection authority.

1.19 **TESTS**

A. Test all equipment installed under these specifications and demonstrate its proper operation to the Engineer.

B. Do not test or operate equipment for any purpose, until it has been fully lubricated in accordance with the manufacturer's instructions and, if it is a centrifugal pump, until it has been connected to the piping system with sufficient water so that it will not run dry.

C. All testing shall be completed before final inspection, and test results shall be available during the final inspection.

1.20 **GUARANTEES**

A. This contractor shall guarantee all equipment, material, and workmanship for a period of one year from date of final certificate. Any defects in mechanical equipment, workmanship or materials that appear, or cause trouble of any kind within a period of one year from date of final certificate shall be remedied, free of charge. Refer to other sections of these specifications for guarantees in excess of the requirements herein described.

PART 2 PRODUCTS

2.1 Not Used

PART 3 EXECUTION

3.1 INSTRUCTION TO OWNER'S EMPLOYEES FORM:

DATE_____

INSTRUCTION OF OWNER'S EMPLOYEES

This letter shall certify that the Contractor has furnished the Owner with full instructions in the care and operation of all parts of the mechanical system as specified under Section 21 0100 paragraph entitled "Instruction of Owner's Employees".

	Initial Instructions			Follow-up Instructions		
Section	Hours	Date	Owners Initials	Hours	Date	Owners Initials
Sprinkler System	_____	_____	_____	_____	_____	_____

Contractor _____

Owner Representative _____

END OF SECTION

SECTION 21 01 50 - FIRE PROTECTION MATERIALS & METHODS

PART 1 GENERAL

1.1 APPLICABILITY

A. This section covers basic materials and methods and applies to and forms a part of each of the sections of Division 21.

B. This work shall be in accordance with this and other applicable sections and/or provisions of these specifications and with the applicable drawings.

1.2 MATERIALS & MANUFACTURERS

A. All materials and equipment shall be new, free of defects, installed in accordance with manufacturer's current published recommendations in a neat manner and in accordance with standard practice of the industry.

B. Certain materials and/or equipment in this specification are specified by manufacturer and catalog numbers. The design was based on the specified equipment and establishes a degree of quality, performance, physical configuration, etc. If the contractor should elect to use equipment other than the equipment used as a basis for design but listed as "acceptable" in the specifications, he shall be responsible for space requirements, configuration, performance, and changes in bases, supports, vibration isolators, structural members, openings in structure and other apparatus that may be affected by its use.

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 COORDINATION OF OPENINGS

A. This contractor shall coordinate all openings required for new piping, equipment, controls, etc. through any structural slabs, beams, or walls. Contractor shall request a copy of the precast concrete shop drawings and verify locations and sizes of all openings required.

B. All costs associated with structural field changes or redesigns of the building systems due to lack of field coordination shall be responsibility of this contractor.

3.2 PROTECTION, DELIVERY AND STORAGE OF MATERIALS

A. Make provisions for the delivery and storage of materials and make the required arrangements with other contractors for the introduction into the building of equipment too large to pass through finished openings.

B. Protect materials and equipment stored on site from weather and moisture by maintaining factory covers and/or suitable weather-proof coverings. For extended outdoor storage, motors shall be removed from equipment and stored separately.

C. The open ends of all piping shall be covered whenever that system is not being worked on, i.e. end of the workday, completion of a section, etc. Covering shall keep dust, garbage, vermin, and other foreign objects out of the piping when the contractor is not on the jobsite.

3.3 CUTTING AND REPAIRING

A. All holes and penetrations required for the installation of the fire protection equipment shall be by the fire protection contractor. This shall include all piping and any other penetration through the wall, floor, or roof.

B. Cutting construction shall be done only with the written permission of the Architect. Cutting shall be done carefully and damage to buildings, pipes, wiring, or equipment as a result of cutting for installation shall be repaired by skilled mechanics of the trade involved at no additional charge to the Owner. This

Contractor shall be responsible for all cutting and patching unless such work has been delegated to the General Contractor.

C. All holes cut into concrete shall be cut by means of power saws or core drills. All unsightly spalls or chips shall be repaired.

D. All openings remaining around pipe penetrations shall be filled, caulked, and painted to match wall. Code approved fire caulking shall be used for all rated penetrations.

3.4 SEALING FLOOR, CEILINGS AND WALL OPENINGS

A. Where pipes pass through walls, ceilings, floors, or partitions, (other than those through fire rated walls or chases) the opening in the construction around the pipe shall not exceed ½ inch average clearance on all sides and shall be sealed to prevent the passage of sound and air. Coordinate wall openings to allow insulation thickness to pass through walls if allowed.

B. The material used to seal space between the wall and the pipe shall be non-combustible caulk type, or wrap type, as conditions require. Provide sheet metal angles or flanges as may be required to contain the stopping material. Use of expanding foam will be allowed if surfaces are cleaned of an excess material and all edges are trimmed smooth. Penetrations through exterior walls shall be sealed weather tight.

C. Special attention shall be given to penetrations of mechanical room walls. Fill gaps around entire exterior area of the pipes with sound insulation (batt or mineral wool) to within ½" of the wall surface. Use silicone caulking to finish filling the opening smooth with the wall surface or provide sheet metal angles. All sealer shall meet flame spread 25 and smoke developed less than 50.

D. Where pipes pass through fire-rated walls, ceilings, floors, vertical service shafts walls, or partitions, the opening in the construction around the pipe or duct shall be fire-stopped to prevent the passage of flame and smoke. All assemblies shall be UL or ASTM listed to provide a fire rating equal to that of the construction being penetrated. For the firestop applications that exist for which no UL tested system is available through a manufacturer, an engineering judgment derived from similar UL system designs or other tests shall be submitted from the manufacturer to the local authorities having jurisdiction for their review and approval prior to installation. Individuals installing the firestopping shall be experienced and certified as required by the manufacturer whose product is being applied. Refer to firestopping spec section for more information.

E. Manufacturer's assembly drawings shall be provided in O & M Manuals for each type of penetration. Printed metal or plastic labels shall be permanently applied on the structure within 6" of the edge of the firestop system. Metal labels shall be applied with mechanical fasteners & plastic labels shall be the self-adhering type with adhesive capable of permanently bonding labels to the surfaces on which the labels are placed. The information required on the label include UL/ASTM assembly number, date of installation, fire stopping material manufacture name, Contractor's name, address & phone number & the installer's name.

F. Acceptable manufacturers shall be Hilti, 3M Brand, or a prior approved product.

3.5 CLEANING AND PAINTING

A. Clear away all debris, surplus materials, etc., resulting from work or operations, leaving the job and equipment furnished under this contract in a clean condition.

B. All equipment being furnished with finished paint coat shall be examined upon job completion for scratches and other surface damage. All finished surfaces where necessary shall be touched up with touch-up paint of color to match the factory finish.

C. Paint all exposed bare pipe exterior of the building. Bare pipe shall be painted one coat of No. 7769402 damp-proof red primer as manufactured by Rust-Oleum Corporation, or equal, and one coat of oil paint. Final coat shall be of a color selected by the architect.

D. Paint all exposed iron and steel work, pipe hangers, pipe stands, uninsulated tanks, supporting steel for equipment and exposed bare pipe in mechanical areas. Iron and steel work and bare pipe shall be painted one coat of No. 4769402 damp-proof red primer as manufactured by Rust-Oleum Corporation, or equal, and one coat of oil paint. Iron and steel work shall be painted black.

E. Refer to Section 09, Painting for additional requirements.

3.6 **ASBESTOS FREE BUILDING**

A. There shall be no products or building materials used as a temporary or permanent element in the construction of this building, which has in its make-up any form of asbestos. The contractors shall be responsible to monitor shop drawings and product literature to verify the make-up of materials to be used in the building and remind material suppliers that their products must be asbestos free.

B. Notify the Architect immediately of any existing materials which are suspected of containing asbestos. Do not disturb or attempt to remove any asbestos containing material. The Architect will contact the Owner and inform them of the Contractors observations. The Owner will obtain and provide the services of professionals skilled in asbestos removal.

3.7 **SALVAGE**

A. All items removed from existing building shall be salvaged in a workmanlike manner.

B. The handling, storage, and disposition of salvage materials shall be as directed by the Architect. Generally, all salvage material shall remain the property of the Owner. Materials and equipment not wanted by Owner shall be removed from the job site and become the property of the contractor.

END OF SECTION

SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 Section Includes

A. Above ground piping.
B. Escutcheons.
C. Mechanical couplings.
D. Pipe hangers and supports.
E. Pipe sleeves.

1.2 Reference Standards

A. ASME A112.18.1 - Plumbing Supply Fittings; 2024.
B. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2025, with Errata.
C. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
D. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
E. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2021.
F. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
G. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2025.
H. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
I. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2024.
J. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).
K. AWWA C606 - Grooved and Shouldered Joints; 2022.
L. FM (AG) - FM Approval Guide; current edition.
M. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
N. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.3 Submittals

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Indicate pipe materials used, jointing methods, supports, and floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
C. Closeout Documents:
   1. Project Record Documents: Record actual locations of components and tag numbering.
   2. Operation and Maintenance Data: Include installation instructions and spare parts lists.

1.4 **QUALITY ASSURANCE**

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
B. Installer Qualifications: Company specializing in performing work of the type specified in this section.

1. Minimum three years experience.

C. Conform to FM (AG) and UL (DIR) requirements.

D. Valves: Bear FM (AG) and UL (DIR) product listing label or marking. Provide manufacturer's name and pressure rating marked on valve body.

E. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

F. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.5 Delivery, Storage, and Handling

A. Deliver and store valves in shipping containers, with labeling in place.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

PART 2 PRODUCTS

2.1 General Requirements

A. Sprinkler-based System:

1. Comply with NFPA 13.
2. See Section 21 13 00.

B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

C. Provide system pipes, fittings, sleeves, escutcheons, seals, and other related accessories.

2.2 Above Ground Piping

A. Steel Pipe: ASTM A53, black.

1. Pipe:
   a. 2" and smaller: Schedule 40
   b. 2-1/2" and larger: Schedule 10 where allowed by owner and AHJ
2. Steel Fittings: ASTM A234/A234M wrought carbon steel or alloy steel.
3. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings and ASME B16.4, threaded fittings.
4. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A47/A47M.
5. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.3 Pipe Sleeves

A. Vertical Piping:

1. Sleeve Length: 1 inch above finished floor.
2. Provide sealant for watertight joint.
3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.

B. Pipe Passing Through Mechanical Floors above Basement:

1. Galvanized steel pipe or black iron pipe with asphalt coating.
2. Connect sleeve with floor plate except in mechanical rooms.

2.4 Escutcheons

A. Manufacturers:

1. Fire Protection Products, Inc: www.fppi.com.com.
2. Tyco Fire Protection Products: www.tyco-fire.com.

3. Viking Group Inc: www.vikinggroupinc.com.

B. Material:

1. Fabricate from nonferrous metal.
2. Chrome-plated.
3. Metals and Finish: Comply with ASME A112.18.1.

C. Construction:

1. One-piece for mounting on chrome-plated tubing or pipe and one-piece or split-pattern type elsewhere.
2. Internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.5 Pipe Hangers and Supports

A. Hangers for Pipe Sizes 1/2 to 8 inch: Carbon steel, adjustable swivel.

B. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

C. Wall Support for Pipe Sizes to 2-1/2 inches and Over: Welded steel bracket with wrought steel clamp.

D. Vertical Support: Steel riser clamp.

E. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2.6 Mechanical Couplings

A. Manufacturers:

1. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
2. Victaulic Company: www.victaulic.com/#sle.

B. Rigid Mechanical Couplings for Grooved Joints:

1. Dimensions and Testing: Comply with AWWA C606.
2. Minimum Working Pressure: 300 psig.
3. Housing Material: Fabricate of ductile iron complying with ASTM A536.
4. Housing Coating: Factory applied orange enamel.
5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
6. Bolts and Nuts: Hot-dipped-galvanized or zinc-electroplated steel.

PART 3 EXECUTION

3.1 Preparation

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and foreign material, from inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.2 Installation

A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.

B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

C. Install piping to conserve building space, to not interfere with use of space and other work.

D. Group piping whenever practical at common elevations.

E. Seal exterior wall penetrations above grade weather tight.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

G. Pipe Hangers and Supports:

1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
2. Place hangers within 12 inches of each horizontal elbow.

3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
4. Coordinate anchor locations with structural. In general, support from top, load bearing portion of structural member.
5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
7. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

H. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

I. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.

J. Structural Considerations:

1. Do not penetrate building structural members unless indicated.

K. Provide sleeves when penetrating floors. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.

1. Aboveground Piping:
   a. Pack solid using mineral fiber complying with ASTM C592.
   b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
2. All Rated Openings: Caulk tight with firestopping material complying with ASTM E814 to prevent the spread of fire, smoke, and gases.

L. Escutcheons:

1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
3. Attach plates at the underside only of suspended ceilings.
4. Use chrome plated escutcheons in occupied spaces and to conceal openings in construction.

M. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.

N. Die-cut threaded joints with full-cut, standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

3.3 Cleaning

A. Upon completion of work, clean all parts of the installation.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION

SECTION 21 05 23 - GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Two-piece ball valves with indicators.
B. Check valves.
C. Bronze OS&Y gate valves.
D. Iron OS&Y gate valves.
E. Trim and drain valves.

1.2 ABBREVIATIONS AND ACRONYMS

A. NRS: Non-rising stem.
B. OS&Y: Outside screw and yoke.
C. PTFE: Polytetrafluoroethylene.

1.3 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
C. ASME B31.9 - Building Services Piping; 2020.
D. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2025, with Errata.
E. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service; 2023.
F. AWWA C606 - Grooved and Shouldered Joints; 2022.
G. FM (AG) - FM Approval Guide; current edition.
H. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. NFPA 13R - Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies; 2025.
J. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.
K. UL 262 - Gate Valves for Fire-Protection Service; Current Edition, Including All Revisions.
L. UL 312 - Check Valves for Fire-Protection Service; Current Edition, Including All Revisions.
M. UL 1091 - Standard for Butterfly Valves for Fire-Protection Service; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Closeout Documents:
   1. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
   2. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Obtain valves for each valve type from single manufacturer.

2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.

B. Where listed products are specified, provide products listed, classified, and labeled by FM (AG), UL (DIR), or testing firm acceptable to authorities having jurisdiction as suitable for the purpose indicated.

C. Welding Materials and Procedures: Comply with ASME BPVC-IX.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Set valves open to minimize exposure of functional surfaces.

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 and maintain at higher than ambient dew point temperature.
   b. If outdoor storage is unavoidable, store valves off the ground in watertight enclosures.

C. Use the following precautions for handling:

1. Do not use operating handles or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B1.20.1 for threads on threaded-end valves.
3. ASME B31.9 for building services piping valves.

B. Comply with AWWA C606 for grooved-end connections.

C. Comply with NFPA 13 and NFPA 13R for valves.

D. Valve Pressure Ratings: Not less than minimum pressure rating indicated or higher as required.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

2.2 TWO-PIECE BALL VALVES WITH INDICATORS

A. UL 1091, except with ball instead of disc and FM (AG) standard listing for indicating valves (butterfly or ball type), Class Number 1112.

B. Description:

1. Minimum Pressure Rating: 175 psig.
2. Body Design: Two piece.
3. Body Material: Forged brass or bronze.
4. Port Size: Full or standard.
5. Seat: PTFE.
6. Stem: Bronze or stainless steel.
7. Ball: Chrome-plated brass.
8. Actuator: Worm gear or traveling nut.

2.3 CHECK VALVES

A. UL 312 and FM (AG) standard listing for check valves, Class Number 1045.

B. Minimum Pressure Rating: 175 psig.
C. Type: Center guided check valve.
D. Body Material: Cast iron, ductile iron.
E. Center guided check with elastomeric seal.
F. Hinge Spring: Stainless steel.
G. End Connections: Flanged, grooved, or threaded.

2.4 BRONZE OS&Y GATE VALVES

A. UL 262 and FM (AG) standard listing for fire-service water control valves (OS&Y and NRS-type gate valves).
B. Minimum Pressure Rating: 175 psig.
C. Body and Bonnet Material: Bronze or brass.
D. Wedge: One-piece bronze or brass.
E. Wedge Seat: Bronze.
F. Stem: Bronze or brass.
G. Packing: Non-asbestos PTFE.
H. Supervisory Switch: External.
I. End Connections: Threaded.

2.5 IRON OS&Y GATE VALVES

A. Listed and Body Marked: AWWA C509, FM (AG), and UL 262.
B. Maximum Working Pressure: 175 psi.
C. Body and Bonnet Material: Cast or ductile iron.
D. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
E. Stem: Brass, bronze, or stainless steel.
F. Packing: Non-asbestos PTFE.
G. Supervisory Switch: External.

2.6 TRIM AND DRAIN VALVES

A. Ball Valves:
1. Description:
a. Pressure Rating: 175 psig.
b. Body Design: Two piece.
c. Body Material: Forged brass or bronze.
d. Port Size: Full or standard.
e. Seat: PTFE.
f. Stem: Bronze or stainless steel.
g. Ball: Chrome-plated brass.
h. Actuator: Hand-lever.

PART 3 EXECUTION

3.1 EXAMINATION

A. Confirm valve interior to be free of foreign matter and corrosion.
B. Remove packing materials.
C. Examine guides and seats by operating valves from the fully open position to the fully closed position.
D. Examine valve threads and mating pipe for form and cleanliness.

3.2 INSTALLATION

A. Comply with specific valve installation requirements and application in the following Sections:
   1. Section 21 13 00 for application of valves in wet and dry pipe, fire-suppression sprinkler systems.
B. Install listed fire protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections.
C. Install check valve in water supply connections and backflow preventer at potable water supply connections.
D. Valves in horizontal piping installed with stem at or above the pipe center.
E. Position valves to allow full stem movement.
F. Install valve tags. Comply with Section 21 05 53 requirements for valve tags, schedules, and signs on surfaces concealing valves; and the appropriate NFPA standard applying to the piping system in which valves are installed.

END OF SECTION

SECTION 21 05 53 - IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Nameplates.
B. Tags.
C. Pipe markers.
D. Ceiling tacks.

1.2 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Closeout Documents:
   1. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
   2. Manufacturer's Installation Instructions: Indicate special procedures, and installation instructions.
   3. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

A. Piping: Pipe markers.
B. Valves: Tags and ceiling tacks where above lay-in ceilings.

2.2 TAGS

A. Manufacturers:
   1. Brimar Industries, Inc: www.pipemarker.com/#sle.
   2. Seton Identification Products, a Tricor Direct Company: www.seton.com.
B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
D. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.3 PIPE MARKERS

A. Manufacturers:
   1. Brimar Industries, Inc: www.pipemarker.com/#sle.
   2. Seton Identification Products, a Tricor Company: www.seton.com.
B. Color: Comply with ASME A13.1.
C. 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.

2.4 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

A. Install tags with corrosion resistant chain.
B. Markers shall be applied where pipes pass through walls (both sides of the wall), at each change of direction and on each 20 feet of straight lengths.
    1. Identify service, flow direction, and pressure.
    2. Install in clear view and align with axis of piping.
C. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
D. Locate ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 21 11 00 - FACILITY FIRE-SUPPRESSION WATER-SERVICE PIPING

PART 1 GENERAL

1.1 Section Includes

A. Water pipe.
B. Valves.
C. Bedding and cover materials.
D. Accessories.

1.2 Reference Standards

A. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
B. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2017a.
C. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals; 2019 (Reapproved 2025).
D. AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings; 2022.
E. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.
F. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2023.
G. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances; 2023.
H. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings; 2021.
I. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. through 60 In. (100 mm through 1500 mm); 2022.
J. AWWA M23 - PVC Pipe—Design and Installation; 2020.
K. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
L. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.3 Submittals

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Include data on pipe materials, pipe fittings, valves, and accessories.
   2. Provide manufacturer's catalog information.
   3. Indicate valve data and ratings.
   4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.
   5. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
C. Closeout Documents:
   1. Record actual locations of piping mains, valves, connections, fire hydrants, free-standing fire department connections, underground manholes and vaults, valve boxes, thrust restraints, and invert elevations.
   2. Maintenance Data: Include installation instructions, spare parts lists, and exploded assembly views.

1.4 Quality Assurance

A. Provide grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.

B. Date stamp castings used for coupling housings, fittings, and valve bodies for quality assurance and traceability.

C. Valves: Bearing product listing label or marking. Provide manufacturer's name and pressure rating marked on valve body.

D. Products:

1. Listed, classified, and labeled as suitable for the purpose specified and indicated.
2. Refer to UL (DIR).

E. Perform Work in accordance with local authorities having jurisdiction, municipality, and water utility requirements.

1.5 Delivery, Storage, and Handling

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.6 Field Conditions

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.1 Water Pipe

A. Ductile Iron Pipe: Listed, AWWA C104/A21.4:

1. Fittings: Ductile iron, standard thickness.
2. Joints: AWWA C111/A21.11, styrene-butadiene rubber (SBR) or vulcanized SBR gasket with rods.
3. Jackets: AWWA C105/A21.5 polyethylene jacket.

B. PVC Pipe: Listed, AWWA C900 Class 100:

1. Fittings: AWWA C111/A21.11, cast iron.
2. Joints: ASTM D3139 compression gasket ring.

2.2 Valves

A. General:

1. Manufacturer's name and pressure rating marked on valve body.
2. Minimum Compliance: UL (DIR) listed and labeled.
3. Maximum Inlet Pressure: 400 psi.
4. Maximum Service Temperature: 180 degrees F.
5. Valve Coatings:
   a. Internally: 4 mils, 0.004 inch epoxy, minimum.
   b. Externally: Epoxy base then fire red enamel paint or heat-fused red epoxy paint.

B. Double Check Detector Valve Assembly, Flanged End:

1. Manufacturers:
   a. Ames Fire and Waterworks: www.amesfirewater.com/#sle.
   b. Deringer
2. 2-1/2 inch NPS to 10 inch NPS:
   a. Construction:

1) Body: 300 Series stainless steel or ASTM A536 Grade 65-45-12 ductile iron.

2) Two independently operating, spring-loaded, check valves.

3) Two OSY resilient seated gate valves.

4) Cam-Check:

a) Internally loaded, providing positive, drip-tight closure against reverse flow.

b) Stainless steel cam arm and spring, rubber-faced disc, and replaceable, thermoplastic seat.

5) Valve Cover:

a) Provides access to all internal parts.

b) Held in place through the use of a single grooved style two-bolt coupling.

2.3 Bedding and Cover Materials

A. Bedding: As specified in Division 31.
B. Cover: As specified in Division 31.

2.4 Accessories

A. Concrete for Thrust Restraints: Concrete type specified in Division 03.
B. Supervisory Switches: See Section 21 13 00 for waterflow and supervisory switches.
C. Tracer Wire:
1. Provide magnetic, detectable conductor with clear plastic covering and imprinted with "Water Service" in large letters.
2. Conductor to be of sufficient length to be continuous over each separate run of nonmetallic pipe.

PART 3 EXECUTION

3.1 Examination

A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

3.2 Preparation

A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
B. Remove scale and dirt on inside and outside before assembly.
C. Prepare pipe connections to equipment with flanges or unions.

3.3 Trenching

A. Earthwork: Perform earthwork operations in accordance with Division 31.
B. Hand trim excavation for accurate placement of pipe to elevations indicated.
C. Form and place concrete for pipe thrust restraints at each change of pipe direction. Place concrete to permit full access to pipe and pipe accessories.
D. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.4 Installation

A. General Requirements:

1. Location of Water Lines:

a. Terminate the work covered by this Section at a point approximately 5 feet from the building unless indicated otherwise.

b. Do not install water line closer horizontally than 10 feet from any sewer line unless indicated otherwise.

c. Water Piping Parallel With Sewer Piping:

1) Install water piping minimum 10 feet horizontally (measured edge-to-edge) from a sewer or sewer manhole where possible.

2) Bottom (Invert) of Water Piping:

a) Minimum 18 inches above top (crown) of sewer piping.

b) Where this vertical separation of 18 inches above top (crown) of sewer piping cannot be obtained, the installation will be acceptable only when sewer piping is constructed of AWWA approved water pipe and pressure tested in place without leakage prior to backfilling.

2. Sleeving:

a. Sleeve water piping where piping is required to be installed within 3 feet of existing structures.

b. Provide ductile iron or Schedule 40 steel sleeves.

c. Fill annular space between pipe and sleeves with mastic.

d. Install water pipe and sleeve without damaging structures or causing settlement or movement of foundations or footings.

3. Pipe Laying and Jointing:

a. Remove fins and burrs from pipe and fittings.

b. Prior to placing in position, clean pipe, fittings, valves, and accessories, and maintain in clean condition.

c. Provide proper facilities for lowering pipe sections into trenches.

d. Dropping or dumping of piping, fittings, valves, or any other water line material into trenches is not permitted.

e. Cut pipe in a neat, workmanlike manner accurately to length established at the site and work into place without forcing or springing.

f. Replace by one of the proper length any pipe or fitting that does not allow sufficient space for proper installation of jointing material.

g. Wedging or blocking between bells and spigots will not be permitted.

h. Install bell-and-spigot pipe with the bell end pointing in the direction of laying.

i. Grade the pipeline in straight lines avoiding the formation of dips and low points.

j. Support piping at proper elevation and grade.

k. Secure firm, uniform support.

l. Wood support blocking will not be permitted.

m. Install pipe so that the full length of each pipe section and each fitting will rest solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings.

n. Provide anchors and supports where indicated and necessary for fastening work into place.

o. Provide proper provisions for expansion and contraction of pipelines.

p. Keep trenches free of water until joints have been properly made.

q. Close open ends of piping temporarily with wood blocks or bulkheads at the end of each workday.

r. Do not install pipe during unacceptable trench conditions or inclement weather.

4. Tracer Wire:
   a. Install continuous length of tracer wire for the full length of each run of nonmetallic pipe.

   b. Attach wire to top of pipe securely to prevent displacement during installation.

5. Connections to Existing Water Lines:
   a. Ensure minimal interruption of service on the existing line.

   b. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped.

B. Special Requirements:
1. Ductile Iron Piping:
   a. Unless otherwise specified, install pipe and fittings in accordance with paragraph "General Requirements".

   b. Jointing:

      1) Make push-on joints with the gaskets and lubricant specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly.

      2) Make mechanical joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly and the recommendations of Appendix A to AWWA C111/A21.11.

3) Make flanged joints with the gaskets, bolts, and nuts specified for this type joint.

a) Make flanged joints up tight; avoid undue strain on flanges, fittings, valves, and other accessories and equipment.

b) Align bolt holes for each flanged joint.

c) Use full size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted.

d) Do not allow adjoining flange faces to be out of parallel to such a degree that the flanged joint cannot be made watertight without over-straining the flange.

e) When flanged pipe or fitting has dimensions that do not allow the making of a proper flanged joint as specified, replace it by one of proper dimensions.

f) Use set-screwed flanges to make flanged joints where conditions prevent the use of full length, flanged pipe and assemble in accordance with the recommendations of the set-screwed flange manufacturer.

c. Allowable Deflection:

1) Maximum Allowable Deflection: As stated in AWWA C600.

2) If the alignment requires deflection in excess of the above limitations, furnish special blends or a sufficient number of shorter pipe lengths to provide angular deflections within the limit set forth.

d. Pipe Anchorage:

1) Provide concrete thrust blocks (reaction backing), for pipe anchorage except where metal harness is indicated.

2) Thrust blocks to comply with the requirements of AWWA C600 for thrust restraint, except that size and positioning of thrust blocks to be as indicated.

3) Use concrete, ASTM C94/C94M, having a minimum compressive strength of 2,500 psi at 28 days; or use concrete of a mix not leaner than one part cement, 2-1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

4) Provide metal harness in accordance with the requirements of AWWA C600 for thrust restraint, using tie rods and clamps as indicated in NFPA 13, except as otherwise indicated.

e. Exterior Protection: Completely encase buried ductile iron pipelines with polyethylene tube or sheet, using Class A polyethylene film, in accordance with AWWA C105/A21.5.

2. PVC Plastic Piping:

a. Unless otherwise specified, install pipe and fittings in accordance with paragraph "General Requirements"; with the requirements of AWWA C605 for laying of pipe, joining PVC

pipe to fittings and accessories, and setting of hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23.

b. Jointing:

1) Push-On Joints:

a) Make push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings.

b) For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel.

c) For push-on joint connections to metal fittings, valves, and other accessories, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint.

d) Use an approved lubricant recommended by the pipe manufacturer for push-on joints.

e) Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of AWWA C605 for laying the pipe and the recommendations in AWWA M23 for pipe joint assembly.

f) Assemble push-on joints for connection to fittings, valves, and other accessories in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories and with the applicable requirements of AWWA C600 for joint assembly.

c. Offset: Maximum offset in alignment between adjacent pipe joints to be as recommended by the manufacturer and approved by the Engineer, not to exceed 5 degrees.

d. Pipe Anchorage:

1) Provide concrete thrust blocks (reaction backing) for pipe anchorage, except where metal harness is indicated.

2) Provide thrust blocks in accordance with the requirements of AWWA C605 for reaction or thrust blocking and plugging of dead ends, except that size and positioning of thrust blocks to be as indicated.

3) Use concrete, ASTM C94/C94M, having a minimum compressive strength of 2,500 psi at 28 days; or use concrete of a mix not leaner than one part cement, 2-1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

4) Provide metal harness as indicated.

e. Fittings: Install in accordance with AWWA C605.

3.5 Field Quality Control

A. Field Tests and Inspections:

1. Provide all labor, equipment, and incidentals required for field testing, except that water and electric power needed for field tests will be furnished as set forth in Section 01 51 00 - Temporary Utilities.
2. Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently and at least 5 days after placing of concrete after concrete thrust blocks have hardened sufficiently and at least 5 days after placing of concrete.
3. Fill pipeline 24 hours before testing and apply test pressure to stabilize system, using only potable water.
4. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
5. Prepare reports of testing activities.

END OF SECTION

SECTION 21 13 00 - FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wet-pipe sprinkler system.

B. System design, installation, and certification.

C. Fire department connections.

1.2 REFERENCE STANDARDS

A. FM (AG) - FM Approval Guide; current edition.

B. NFPA 1963 - Standard for Fire Hose Connections; 2019.

C. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

D. UL 405 - Standard for Safety Fire Department Connection Devices; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.

B. Shop Drawings:

1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components, and accessories. Indicate system controls.
3. Submit shop drawings to Authorities Having Jurisdiction for approval. Submit proof of approval to Engineer.

C. Closeout Documents:

1. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.
2. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   a. Extra Sprinklers: Type and size matching those installed in quantity required by referenced NFPA design and installation standard.
   b. Sprinkler Wrenches: For each sprinkler type.
3. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

1.4 QUALITY ASSURANCE

A. Comply with FM (AG) requirements.

B. Designer Qualifications: Design of the system including all shop drawings, calculations, and other submittals shall be completed by a technician with a minimum NICET Level III certification or by a registered Professional Engineer who has passed the NCEES professional engineering exam for fire protection and is licensed in the State in which the Project is located.

C. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

D. Installer Qualifications: Company specializing in performing the work of this section with minimum five years experience and approved by manufacturer.

E. Equipment and Components: Provide products that bear FM (AG) label or marking.

F. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Sprinklers, Valves, and Equipment:
1. Deringer
2. Tyco Fire Protection Products: www.tyco-fire.com.
3. Viking Corporation: www.vikinggroupinc.com.
4. Victaulic
5. Reliable Automatic Sprinkler Co.

2.2 SPRINKLER SYSTEM

A. Sprinkler System: Provide coverage for the entire new school and for areas indicated in Jefferson..
B. Occupancy: Comply with NFPA.
C. Water Supply: Determine volume and pressure from water flow test data.
D. Provide fire department connections where indicated.
E. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.

2.3 SPRINKLERS

A. Suspended Ceiling Type: Concealed pendant type with matching push on escutcheon plate.
1. Response Type: Quick.
2. Coverage Type: Standard.
3. Finish: Chrome plated.
4. Cover Plate Finish: White.
5. Fusible Link: Glass bulb type temperature rated for specific area hazard.

B. Hard Ceiling Type: Concealed pendant type.
1. Response Type: Quick.
2. Coverage Type: Standard.
3. Finish: Chrome plated.
4. Cover Plate Finish: White.
5. Fusible Link: Glass bulb type temperature rated for specific area hazard.

C. Exposed Area Type: Pendant type.
1. Response Type: Quick.
2. Coverage Type: Standard.
3. Finish: Brass.
4. Fusible Link: Glass bulb type temperature rated for specific area hazard.

D. Head Guards: Finish to match sprinkler finish. Provide for gymnasiums, hockey rinks, fitness and recreation centers and rack storage areas.
1. Provide head guards in gymnasiums, mechanical rooms, near shelving and other areas subject to damage.
2. Inline SprinkGAURD powder coated steel.

E. Flexible Drop System: Stainless steel, multiple use, open gate type.
1. Application: Use to properly locate sprinkler heads.
2. Include all supports and bracing.
3. Provide braided type tube as required for the application.
4. Manufacturers:

a. Victaulic Company; Vic-Flex: www.victaulic.com/#sle.

2.4 PIPING SPECIALTIES

A. Backflow Preventer: Double check valve assembly backflow preventer with drain and OS & Y gate valve on each end.

B. Test Connections:

1. Inspector's Test Connection for Preaction Systems:

a. Provide test connections approximately 6 ft above floor for each or portion of each sprinkler system equipped with an alarm device, located at the most remote part of each system.

b. Route test connection to an open-site drain location, excluding janitor sinks, accepting full flow without negative consequences.

c. Supply discharge orifice with same size as corresponding sprinkler orifice.

d. Limit vertical height of exterior wall penetration to 2 ft above finished grade.

2. Backflow Preventer Test Connection:

a. Provide downstream of the backflow prevention assembly, listed hose valves with 2.5 inch National Standard male hose threads with cap and chain.

b. Furnish one valve for each 250 gpm of system demand or fraction thereof.

c. Provide permanent sign reading "Test Valve" in accordance with Section 21 05 53.

C. Electric Alarm: UL listed audible strobe with 3 selectable dBA settings NEMA 4x rated for outdoor installations. Wired to flow and/or pressure switch on sprinkler zone piping. Provide switching relay for multiple zone valve input.

D. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.

E. Fire Department Connections:

1. Type: Exposed, projected wall mount made of corrosion resistant metal complying with UL 405.

a. Inlets: Two way, 2-1/2 inch swivel fittings, internal threaded. Thread size and inlets according to NFPA 1963 or Authority Having Jurisdiction. Brass caps with gaskets, chains, and lugs.

b. Outlet: Back with pipe threads, 4 NPS.

c. Finish: Brass or bronze.

d. Signage: Raised or engraved lettering 1 inch minimum indicating system type.

e. Manufacturers:

1) Elkhart Brass Manufacturing Company, Inc: www.elkhartbrass.com.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with referenced NFPA design and installation standard.

B. Install equipment in accordance with manufacturer's instructions.

C. Provide approved double check valve assembly at sprinkler system water source connection.

D. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle.

E. Place pipe runs to minimize obstruction to other work.

F. Place piping in concealed spaces above finished ceilings.

G. Center sprinklers in two directions in ceiling tile and provide piping offsets as required.

H. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.

I. Flush entire piping system of foreign matter.

J. Install guards on sprinklers where indicated.

K. Hydrostatically test entire system.

L. Require test be witnessed by Fire Marshal.

3.2 INTERFACE WITH OTHER PRODUCTS

A. Ensure required devices are installed and connected as required to fire alarm system.

END OF SECTION

SECTION 22 00 60 - PLUMBING & PIPING DEMOLITION

PART 1 GENERAL

1.1 DESCRIPTION

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

B. This section specifies the demolition and removal of all plumbing equipment and distribution conduits including but not limited to air outlets, piping, insulation, plumbing fixtures and accessories in existing building.

C. Unless otherwise noted in the Documents, all salvage items removed in connection with this Contract are to become the property of the Contractor, however the Owner shall have the first right of refusal on all equipment removed.

1.2 SUBMITTALS

A. Proposed Dust Control and Noise Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.

B. Schedule of selective demolition activities:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Interruption of building utility services.
3. Coordination for shutoff, capping and continuation of services.
4. Coordination of Owner's continued occupancy of portions of existing building and of Owner's occupancy of completed work.

C. Pre-demolition photographs or videotape showing existing pre-demolition conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective demolition operations. Submit before demolition work begins.

1.3 PROJECT CONDITIONS

A. Owner will occupy portions of the building immediately adjacent to selective demolition area. Conduct demolition so Owner's operation will not be disturbed. Provide not less than 48-hour notice to Owner of activities that will affect the Owner's operations.

B. Maintain existing services to Owner occupied areas during demolition if possible or coordinate interruption of services prior to demolition.

C. Owner assumes no responsibility for condition of area to be selectively demolished.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

E. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify the Owner. Hazardous materials will be removed by Owner under a separate contract.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify field measurements and existing ductwork and piping arrangements are as shown on Drawings.

B. Verify that abandoned equipment serves only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents. The demolition Drawings are diagrammatic and show the general scope of demolition work and do not show

all the construction detail of the original record drawings. Report discrepancies to the Project Engineer before disturbing existing installation.

D. The Contractor shall visit the existing building and grounds and review the existing building record drawings for details of existing installation to familiarize themselves with existing conditions prior to submitting bid. No allowance will be made subsequently, in this connection, on behalf of the Contractor for any error or negligence on his part.

E. Beginning of demolition means the Contractor accepts existing conditions.

3.2 **PREPARATION**

A. Disconnect mechanical systems in areas scheduled for removal. Notify Project Engineer and Owner of areas to be affected by mechanical demolition work prior to commencing.

B. Disconnect utilities in areas scheduled for removal. Notify Project Engineer and Owner of areas to be affected by plumbing demolition work prior to commencing.

3.3 **SELECTIVE DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK**

A. Demolish and remove from site and extend existing mechanical work under provisions of this Division and as indicated on the Drawings unless otherwise noted.

B. Salvage items noted to remain the property of the Owner shall be delivered to a location to be designated by the Owner. Contractor shall remove from construction areas all trash or debris as it accumulates and dispose of it off site at no additional cost to the Owner. All construction areas shall be kept clean, safe, and orderly at all times. At the completion and acceptance for work, Contractor shall remove from the site all debris and surplus materials resulting from this work and dispose of them off site at no additional cost to the Owner.

C. Do not use cutting torches until work area is clear of flammable materials. At concealed spaces verify condition and contents of hidden space before starting flame cutting operations. Maintain Fire Watch and portable fire-suppression devices during flame-cutting operations. Maintain and evaluate ventilation during flame-cutting operations.

D. Maintain ventilation for dust control during selective demolition process. Verify Owner requirements for dust control and conform to their standards for all demolition activities.

E. Remove, relocate, and extend existing installations to accommodate new construction as required for proper installation and system operation.

F. Remove all accessories above grade. When removing equipment or terminal devices all associated pipe, etc. shall be removed and capped as required. Cut piping, tubing, etc. behind walls, above ceilings and below floors, and patch surfaces to match existing conditions. Finishes will be by others unless otherwise noted in documents.

G. Fill all abandoned waste lines below floor slabs with low stress grout.

H. Neatly cut openings and holes plumb, square and true to dimension required. Use cutting methods least likely to damage construction to remain or adjoining construction. Cut and drill from exposed surfaces into concealed surfaces to avoid marring or spalling of finished surfaces. Temporarily cover openings to remain.

I. Patch all openings created by removal of mechanical equipment, ATC devices, ducts, pipes, etc. unless noted as being patched by others. Openings to be patched to match existing with similar materials and finish unless otherwise noted.

J. Seal all existing roof penetrations, which will not be reused. Roof patching shall be by project roofing contractor, or an Owner approved roofing contractor.

K. Remove, relocate, or provide brackets, hangers, and other accessories as required.

L. Repair adjacent construction and finishes damaged during demolition and extension work.

M. Maintain access to existing mechanical installations, which remain active.

3.4 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment, which remain or are to be returned to the Owner.

B. All building surfaces damaged and openings left by new Work or the removal or relocation of mechanical equipment, piping, etc., shall be repaired to original condition and painted by the Contractor.

END OF SECTION

SECTION 22 01 00 - PLUMBING GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 **APPLICABILITY**

A. This section applies to and forms a part of each of the sections of Division 22. This section, and each of the sections to which it applies, is subject to the requirements of the Instructions to Bidders, General Conditions, and Special Conditions of these complete specifications.

B. The work covered by this Division of the Specifications consists of furnishing all labor, supervision, equipment, materials, all incidentals, related items, and appurtenances, and performing all operations necessary to complete the installation of work in strict accordance with these specifications and drawings.

C. Only such items as are hereinafter specified or indicated on the drawings to be furnished by others, shall be considered to be furnished by others. All other items are to be considered as a part of this Contract and shall be so bid.

D. The omission of specific reference to any parts necessary to, or reasonably incidental to, a complete installation shall not be construed as releasing the Contractor from furnishing and installing same.

E. All work shall be finished, tested and ready for operation.

1.2 DEFINITIONS

A. Word "Furnish" where written in Division 22 specifications and drawings shall mean Contractor shall deliver to the site item(s) specified, as well as additional specialized materials and/or accessories necessary for the use and operation of item or items specified.

B. Word "Install" where written in Division 22 specifications and drawings shall mean Contractor shall set in position, connect (including sub-assemblies furnished), and adjust for use. Contractor shall furnish miscellaneous specialty items such as hangers, valves, unions, piping, sheet metal, etc., as obviously necessary for a complete and operating installation.

C. Word "Material" where written in Division 22 specifications and drawings shall mean any and all apparatus, equipment, devices, fixtures, components, products, assemblies, items, parts, things, and any other pieces specified or shown or required.

D. Word "Labor" where written in Division 22 specifications and drawings shall mean any and all physical effort, manpower, time, expertise, tools, equipment, and services to carefully assemble, install and affix all material in a proper, complete, and acceptable manner.

E. Word "Provide" where written in Division 22 specifications and drawings shall mean "Mechanical Contractor shall furnish all labor and material and completely and properly install such material and leave same in acceptable condition and intended acceptable working order".

1.3 **DISCREPANCIES OR OMISSIONS FROM DRAWINGS OR DOCUMENTS**

A. Notify the Engineer of any discrepancies in, or omissions from the drawings or documents. Neither the Owner nor the Architect will be responsible for any oral instructions or modifications of the specifications or drawings. Written interpretations will be made only by Addenda.

B. If discrepancies are not reported, the contractor shall bid the greater quantity or better quality (highest dollar value), and appropriate adjustment will be made after contract award.

C. Discrepancies discovered during construction shall immediately be called to the attention of the Architect/Engineer for clarification.

D. All minor items necessary for the completion and successful operation of the system, whether or not herein definitely specified or indicated on the drawings, shall be furnished, and installed.

E. Omission of/or express reference to any material necessary for/or reasonably incidental to complete installation shall not release Contractor from providing such material. Where material is shown on drawings but is not specified or is specified but not shown, such material shall be considered both shown and specified.

F. Any work not clear to Contractor shall be referred to Engineer for clarification before bid is submitted. If no question is raised prior to opening of bid, Contractor shall be required to provide work in question as directed by Engineer, whose decision is final, without additional charges.

G. By virtue of submitting a bid, Contractor agrees that he is skilled and experienced in use of and in interpretation of drawings and specifications. Contractor further agrees that he has carefully reviewed all drawings, all specifications, and all addenda, which constitute bid documents for this contract, and finds them free of ambiguities and good and sufficient for bidding and construction purposes.

1.4 **DRAWINGS**

A. The drawings indicate the extent and general layout of the mechanical systems intended for the building. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, connections, and accessories which may be required. Furnish offsets, fittings, valves, and accessories as may be required, to produce a complete and operating installation of type shown and specified.

B. All piping and ductwork shall be routed so as not to obstruct access to other equipment (i.e. VAV box controls, electrical devices, fire alarm devices, etc.). Routing indicated on drawings is representative of intended location but shall be field verified. It shall be this contractor’s responsibility to coordinate with other trades for accessibility.

C. Any work or system on the roof not explicitly indicated on the roof plan shall be approved by the engineer prior to installing.

D. In general, the mechanical equipment drawings are drawn to scale as noted. Obtain dimensions and locations of partitions, walls, etc., from the Architectural drawings wherever possible and do not scale the mechanical drawings. Consult the Architectural drawings for details of construction, location of suspended ceilings, ceiling heights, and other pertinent information. Architect's drawings shall not take precedence over field measurements.

E. All drawings and specifications shall be considered in bidding. The drawings and specifications are complimentary, and what is called for in either of these shall be as binding as though called for by both. Should any conflict arise between drawings and specifications, such conflict shall be brought to the attention of the Architect.

1.5 SITE INSPECTION

A. Before submitting a proposal for the work contemplated in these specifications and accompanying drawings, each bidder shall examine the site and familiarize themself with all the existing conditions and limitations, including the extent of demolition, cutting, and patching to be done by the Contractor for Mechanical Work. No extras will be allowed because of the Contractor's misunderstanding as to the amount of work involved, or his lack of knowledge of any condition in connection with the work.

1.6 **PRIOR APPROVAL REQUESTS**

A. Where the Bid Documents stipulate a particular Product, substitutions will be considered by the Engineer up to 10 days before receipt of bids.

B. The submission shall provide complete information, test, etc. relating to quality, performance, suitability, to determine acceptability of such products.

C. When a request to substitute a Product is made, the Engineer may approve the substitution and will issue an Addendum to known bidders.

D. Provide Products as specified unless substitutions are submitted in this manner and subsequently accepted.

E. The cost of any changes of other trades as a result of use of the substitution material or equipment must be borne by the Contractor submitting such material or equipment.

1.7 **REVIEW OF MECHANICAL MATERIALS AND EQUIPMENT**

A. Within thirty (30) days after award of construction contracts, Contractor shall submit for acceptance to the Architect quantity of shop drawings specified for the equipment indicated in these specifications. The

shop drawings shall include the equipment manufacturer's name and address, catalog designation or model number, rough-in data & dimensions, performance curves and rated capacities & operational characteristics.

B. The Contractor shall thoroughly review each item for compliance with these Specifications making any necessary corrections prior to submittal. Each shop drawing set shall be stamped, signed, and dated indicating Contractor review and submitted electronically via PDF file format. The PDF file name shall include the relevant specification section number for reference. If the Contractor fails to properly review shop drawings, the Contractor shall reimburse the Engineer for all additional reviews on a time and material basis.

C. Provide samples of materials or equipment proposed to be furnished, if requested. Samples shall become the property of the Architect/Engineer and will be returned only when accompanied by a written request to do so.

D. None of the items listed shall be purchased, delivered to the site, or installed, until the item is reviewed. No substitution will be permitted after review except where such substitution is considered by the Architect to be in the best interest of the Owner.

E. The Engineer will review all Shop Drawings submitted and will retain a copy for record file.

F. Approval Stamp: This review is to verify general conformance with the design concept of the Project and substantial compliance with the information provided in the Contract Documents. This review does not in any way relieve the Contractor or their suppliers of their responsibility to provide all materials and equipment as specified, in quantities, quality and dimensions required. Submittals will be reviewed with the following actions:

1. "No Exception Noted" indicates that the Submittal appears to conform to the design concept of the Work and that the Contractor, at his discretion, may with fabrication and/or procurement and installation.
2. "Make Corrections Noted" indicates that the Submittal, after noted corrections are made, appears to conform to the design concept of the Work and that the Contractor, at his discretion, may proceed with fabrication and/or procurement and installation, if the corrections are accepted by the Contractor without any increase in Contract Sum or Time.
3. "Revised and Resubmit" indicates that the noted revisions are such that a corrected copy of the Submittal is required for review to confirm that the noted revisions have been understood and made. The Contractor, at his discretion, may proceed with fabrication and/or procurement and installation after submitting a corrected copy and verifying with the reviewer that the corrected copy is acceptable, if the corrections are accepted by the Contractor without an increase in the Contract Sum or Time.
4. "Rejected" indicates that the Submittal does not appear to conform to the specifications, a resubmission is required, and fabrication or procurement is not authorized.

G. If the Engineer rejects (Revised and Resubmit or Rejected) the same section two times the engineer shall be compensated for additional reviews. Any subsequent submittal will require the inclusion of a check made out to the engineer in the amount of $ 500.00. Contractor is responsible for all delays caused by the resubmittal process.

H. Should the contractor fail to comply with any of the requirements of the preceding sub-paragraphs; then the right is reserved by the Architect to select any or all items in the material schedule, with that selection to be final and binding upon the contractor. The materials selected or reviewed, as the case may be, by the Architect, shall be used in the work at no additional cost to the Owner.

I. When the contractor chooses to furnish and reviewed material or equipment that requires electrical specifications/connections (circuit breaker, conduit, wire, labor, etc.) different than shown and/or scheduled on the drawings, or specified in detail, the contractor shall be responsible for coordinating any necessary changes and shall bear the cost of such changes (including engineering costs).

1.8 proposal requests and instructions

A. For any proposal request or instruction that requires an adjustment to the Contract Sum, submit an itemized quotation for the change(s) described in the proposed modifications to the Contract

Documents. Proposal shall also indicate credits, deducts, and/or offsets for material and labor originally included in contract.

1. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. Breakdown shall include amounts, lengths, quantities, types, sizes, etc. of material.
2. Indicate applicable taxes, O&P, delivery charges, equipment rental, and other incidental charge.
3. Include costs of labor and supervision directly attributable to the change.
4. All sub-contractor pricing shall include the same breakdown as described above.

1.9 **warranty**

A. All equipment and installation shall be provided with a 1-year warranty beginning with substantial completion.

B. Refer to individual spec sections for specific warranty information that is different than stated above.

C. Submit warranty with related forms completed in Owner's name and registered with manufacturer.

1.10 **MANUALS**

A. In addition to catalog data and shop drawings submitted for review, this contractor shall furnish two (2) final Operation and Maintenance Manuals for the mechanical systems. Manuals shall be delivered to the Architect before final observation of the work.

B. Operation and Maintenance Manuals shall be furnished in PDF electronic format as well as two (2) copies bound in new hard backed 3 ring binders with the title "Operations and Maintenance Manuals" and the project title clearly printed on the front cover and side of binder .

C. Provide an index at the beginning of the manual for the sections included in the manual.

D. All sections in hard copy manuals shall be referenced with plastic tabs.

E. Include at the front of the manual a complete listing of the Architect, Engineer and contractors and sub-contractors used on the project. Listing shall include names, addresses and phone numbers for each.

F. Manuals shall be arranged in order similar to the specifications. All major pieces of equipment shall be referenced with tabs. At the beginning of each section, the equipment supplier's name, address, and phone number shall be provided.

G. Data for equipment included in the manuals shall include:

1. Approved shop drawings clearly showing the models, sizes and capacities of equipment used.
2. Operations Manuals detailing step by step procedure to follow putting the equipment into operation.
3. Maintenance Manuals from the manufacturer of each piece of equipment including instructions on installation, maintenance, and lubrication. Manuals shall include parts lists for all replacement parts.

H. The following items shall also be included in the manuals for the Owners information: Factory start-up reports, Valve Tag list, and Signed owner instruction forms for all items specified as requiring owners instruction

I. Operations and Maintenance Manuals shall be submitted to the Engineer for approval prior to delivery to the Architect.

1.11 **INSTRUCTION OF OWNER'S EMPLOYEES**

A. Furnish, without additional expense to the Owner, the services of competent instructors, who will give full instructions in the care, adjustment, and operation of all parts of the mechanical equipment to the Owner's employees who are to have charge of the equipment.

B. An Operating and Maintenance Manual shall be made available to the Owner's operating personnel during the instruction and left with the Owner upon completion of the instruction.

C. The number of man hours of instruction furnished for each system shall be as specified below. Hours of instruction shall be divided up into a minimum of two (2) instruction periods with 75% of time used for an initial instruction and 25% of time used for a follow up instruction, a minimum of four (4) weeks after initial instruction.

D. “Instruction of Owner's Employees" form at end of section shall be filled out and signed by Contractor and Owner's Representative and three (3) signed copies of form sent to Engineer.

E. Owner training and instructions:

1. Plumbing systems including but not limited to water heaters, water softeners, sump pumps and controls, interceptors, and plumbing fixtures shall not be less than four (4) man hours.

1.12 INSTALLATION OF EQUIPMENT

A. All equipment shall be installed and connected in accordance with manufacturer's instructions and recommendations unless such instructions are in conflict with these specifications. Auxiliary piping, valves, electrical connections, etc., recommended by the manufacturer or required for proper operation shall be furnished and installed complete.

B. All equipment shall be installed in such a manner and location as to facilitate accessibility for maintenance and/or replacement.

1.13 RECORD DRAWING

A. The contractor shall maintain one set of drawings at the job site used as a master copy. Each change order or other revision, deletion, or addition shall be clearly marked and noted by colored pencil. This copy of plans shall be furnished to the Architect upon completion of the project.

B. The contractor shall note on the record drawings the elevations and/or inverts of water service where it exits the building foundation.

1.14 COOPERATION WITH OTHER TRADES

A. Cooperate with other trades so as to avoid interferences. Where required to avoid interferences with other work or to increase the headroom. Carefully check all construction details to assure the proper installation of all work under this specification. Schedule the work such that it will keep pace with the work of other crafts and cause no delay.

1.15 INSPECTION OF SITE

A. Before submitting a proposal on the work contemplated in these specifications and accompanying drawings, each bidder shall examine the site and familiarize themself with all of the existing conditions and limitations. No extras will be allowed because of Contractor's misunderstanding as to the amount of work involved or lack of his knowledge of any condition in connection with the new construction.

1.16 PAVEMENT, CURB AND SIDEWALK REPLACEMENT

A. This Contractor shall be responsible for replacement of existing street pavement, curbs, and sidewalks, etc., removed or damaged by them during the course of the work, unless such pavement, curbs, sidewalks are to be constructed under the General Contract. The work shall be done in accordance with local requirements.

1.17 CODES, ORDINANCES, REGULATIONS & STANDARDS

A. The entire installation shall be made in accordance with all state and local laws. If, in any instance, the plans and specifications conflict with such laws, the law shall take precedence. This, however, shall not be construed as relieving the contractor from complying with any requirements of the drawings and specifications that may be in excess of the rules and not contrary to the same.

B. All work shall conform to applicable state and local codes, ordinances, regulations and/or standards.

1.18 **PERMITS AND LICENSES**

A. This contractor shall obtain and pay for all licenses and permits and shall pay for all fees and charges for the connection to outside services and use of property other than the site of the work for storage of materials or other purposes.

B. Contractor shall coordinate and request all inspections from authority having jurisdiction. The Contractor shall notify the Architect of all such coordinated inspections (date & time) and shall submit certificates of inspection and final approval of the local inspection authority.

1.19 **TESTS**

A. Test all equipment installed under these specifications and demonstrate its proper operation to the Engineer.

B. Do not test or operate equipment for any purpose, until it has been fully lubricated in accordance with the manufacturer's instructions and, if it is a centrifugal pump, until it has been connected to the piping system with sufficient water so that it will not run dry.

C. All testing shall be completed before final inspection, and test results shall be available during the final inspection.

1.20 **GUARANTEES**

A. This contractor shall guarantee all equipment, material, and workmanship for a period of one year from date of final certificate. Any defects in mechanical equipment, workmanship or materials that appear, or cause trouble of any kind within a period of one year from date of final certificate shall be remedied, free of charge. Refer to other sections of these specifications for guarantees in excess of the requirements herein described.

PART 2 PRODUCTS

2.1 Not Used

PART 3 EXECUTION

3.1 **INSTRUCTION TO OWNER'S EMPLOYEES FORM:**

DATE _____

INSTRUCTION OF OWNER'S EMPLOYEES

This letter shall certify that the Contractor has furnished the Owner with full instructions in the care and operation of all parts of the plumbing system as specified under Section 22 0100 paragraph entitled "Instruction of Owner's Employees".

Owner's Initial Instructions				Owner's Follow-up Instructions		
Section	Hours	Date	Initials	Hours	Date	Initials
Plumbing						
Contractor						
Owner's Representative						

END OF SECTION

SECTION 22 01 50 - PLUMBING & PIPING MATERIALS & METHODS

PART 1 GENERAL

1.1 APPLICABILITY

A. This section covers basic materials and methods and applies to and forms a part of each of the sections of Division 22.

B. This work shall be in accordance with this and other applicable sections and/or provisions of these specifications and with the applicable drawings.

1.2 MATERIALS & MANUFACTURERS

A. All materials and equipment shall be new, free of defects, installed in accordance with manufacturer's current published recommendations in a neat manner and in accordance with standard practice of the industry.

B. Certain materials and/or equipment in this specification are specified by manufacturer and catalog numbers. The design was based on the specified equipment and establishes a degree of quality, performance, physical configuration, etc. If the contractor should elect to use equipment other than the equipment used as a basis for design but listed as "acceptable" in the specifications, he shall be responsible for space requirements, configuration, performance, and changes in bases, supports, vibration isolators, structural members, openings in structure and other apparatus that may be affected by its use.

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 COORDINATION OF OPENINGS

A. This contractor shall coordinate all openings required for new piping, equipment, controls, etc. through any structural slabs, beams, or walls. Contractor shall request a copy of the precast concrete shop drawings and verify locations and sizes of all openings required.

B. All costs associated with structural field changes or redesigns of the building systems due to lack of field coordination shall be responsibility of this contractor.

3.2 PIPE AND FITTING INSTALLATION

A. Plastic DWV piping shall be installed as addressed by IAPMO (UPC) code section on Expansion and Contraction. Any straight runs of plastic DWV piping exceeding 30 feet shall be installed to accommodate thermal expansion.

B. Piping is to be installed as shown on the drawings as much as practical. When a pipe size is not indicated, the subcontractor shall request the pipe size from the Architect through the Plumbing Contractor.

C. Provide sufficient swing joints, expansion loops, and/or devices necessary and install so as to permit free expansion and contraction of piping without causing undue stresses. Make all changes in direction with fittings. Support piping independently at all equipment so that its weight shall not be supported by the equipment.

D. Install piping without springing or forcing and clear all windows, doors, and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted.

E. All pipes shall be reamed to full pipe diameter before joining.

F. Install vertical risers plumb and straight, horizontal lines parallel with walls and partitions. Conceal piping above ceilings and within furring and/or walls when practical.

G. Provide shut-off valves and unions suitably located to isolate each item of equipment, branch circuit or section of piping.

H. Provide 1/2" drain valves at all low points of each system to enable complete drainage.

I. Provide "Clearflow" dielectric waterways at all junctions of dissimilar metals in potable water systems.

J. All piping shall be adequately supported from the building structure with adjustable hangers to maintain uniform grading where required and to prevent sagging or pocketing.

K. Provide supports between piping and building structure where necessary to prevent swaying.

L. The use of wire or perforated metal to support pipe will not be permitted.

3.3 PROTECTION, DELIVERY AND STORAGE OF MATERIALS

A. Make provisions for the delivery and storage of materials and make the required arrangements with other contractors for the introduction into the building of equipment too large to pass through finished openings.

B. Protect materials and equipment stored on site from weather and moisture by maintaining factory covers and/or suitable weather-proof coverings. For extended outdoor storage, motors shall be removed from equipment and stored separately.

C. The open ends of all piping shall be covered whenever that system is not being worked on, i.e. end of the workday, completion of a section, etc. Covering shall keep dust, garbage, vermin, and other foreign objects out of the piping when the contractor is not on the jobsite.

3.4 CUTTING AND REPAIRING

A. All holes and penetrations required for the installation of the plumbing equipment shall be by the plumbing contractor. This shall include all piping, ductwork, and any other penetration through the wall, floor, or roof.

B. Cutting construction shall be done only with the written permission of the Architect. Cutting shall be done carefully and damage to buildings, pipes, wiring, or equipment as a result of cutting for installation shall be repaired by skilled mechanics of the trade involved at no additional charge to the Owner. This Contractor shall be responsible for all cutting and patching unless such work has been delegated to the General Contractor.

C. All holes cut into concrete shall be cut by means of power saws or core drills. All unsightly spalls or chips shall be repaired.

D. All openings remaining around duct and pipe penetrations shall be filled, caulked, and painted to match wall. Code approved fire caulking shall be used for all rated penetrations.

3.5 SEALING FLOOR, CEILINGS AND WALL OPENINGS

A. Where pipes pass through walls, ceilings, floors, or partitions, (other than those through fire rated walls or chases) the opening in the construction around the pipe shall not exceed ½ inch average clearance on all sides and shall be sealed to prevent the passage of sound and air. Coordinate wall openings to allow insulation thickness to pass through walls if allowed.

B. The material used to seal space between the wall and the pipe shall be non-combustible caulk type, or wrap type, as conditions require. Provide sheet metal angles or flanges as may be required to contain the stopping material. Use of expanding foam will be allowed if surfaces are cleaned of an excess material and all edges are trimmed smooth. Penetrations through exterior walls shall be sealed weather tight.

C. Special attention shall be given to penetrations of mechanical room walls. Fill gaps around entire exterior area of the pipes with sound insulation (batt or mineral wool) to within ½” of the wall surface. Use silicone caulking to finish filling the opening smooth with the wall surface or provide sheet metal angles. All sealer shall meet flame spread 25 and smoke developed less than 50.

D. Where pipes pass through fire-rated walls, ceilings, floors, vertical service shafts walls, or partitions, the opening in the construction around the pipe or duct shall be fire-stopped to prevent the passage of flame and smoke. All assemblies shall be UL or ASTM listed to provide a fire rating equal to that of the construction being penetrated. For the firestop applications that exist for which no UL tested system is available through a manufacturer, an engineering judgment derived from similar UL system designs or other tests shall be submitted from the manufacturer to the local authorities having jurisdiction for their review and approval prior to installation. Individuals installing the firestopping shall be experienced and

certified as required by the manufacturer whose product is being applied. Refer to firestopping spec section for reposition finned element to be centered under windows as required.more information.

E. Manufacturer's assembly drawings shall be provided in O & M Manuals for each type of penetration. Printed metal or plastic labels shall be permanently applied on the structure within 6" of the edge of the firestop system. Metal labels shall be applied with mechanical fasteners & plastic labels shall be the self-adhering type with adhesive capable of permanently bonding labels to the surfaces on which the labels are placed. The information required on the label include UL/ASTM assembly number, date of installation, fire stopping material manufacture name, Contractor's name, address & phone number & the installer's name.

F. Acceptable manufacturers shall be Hilti, 3M Brand, or a prior approved product.

3.6 CLEANING AND PAINTING

A. Clear away all debris, surplus materials, etc., resulting from work or operations, leaving the job and equipment furnished under this contract in a clean condition.

B. All equipment being furnished with finished paint coat shall be examined upon job completion for scratches and other surface damage. All finished surfaces where necessary shall be touched up with touch-up paint of color to match the factory finish.

C. Paint all exposed bare pipe exterior of the building. Bare pipe shall be painted one coat of No. 7769402 damp-proof red primer as manufactured by Rust-Oleum Corporation, or equal, and one coat of oil paint. Final coat shall be of a color selected by the architect.

D. Paint all exposed iron and steel work, pipe hangers, pipe stands, uninsulated tanks, supporting steel for equipment and exposed bare pipe in mechanical areas. Iron and steel work and bare pipe shall be painted one coat of No. 4769402 damp-proof red primer as manufactured by Rust-Oleum Corporation, or equal, and one coat of oil paint. Iron and steel work shall be painted black.

E. Refer to Section 09, Painting for additional requirements.

3.7 ASBESTOS FREE BUILDING

A. There shall be no products or building materials used as a temporary or permanent element in the construction of this building, which has in its make-up any form of asbestos. The contractors shall be responsible to monitor shop drawings and product literature to verify the make-up of materials to be used in the building and remind material suppliers that their products must be asbestos free.

B. Notify the Architect immediately of any existing materials which are suspected of containing asbestos. Do not disturb or attempt to remove any asbestos containing material. The Architect will contact the Owner and inform them of the Contractors observations. The Owner will obtain and provide the services of professionals skilled in asbestos removal.

3.8 HOUSEKEEPING PAD FOR MACHINERY (BY MECHANICAL)

A. Housekeeping Pad Sub-bases shall be provided for all machinery such as water heaters, pumps, and/or where called out on plans.

B. Housekeeping pads shall be a minimum of 4-inches thick and shall follow all manufacturer's instructions and requirements for support.

3.9 SALVAGE

A. All items removed from existing building shall be salvaged in a workmanlike manner.

B. The handling, storage, and disposition of salvage materials shall be as directed by the Architect. Generally, all salvage material shall remain the property of the Owner. Materials and equipment not wanted by Owner shall be removed from the job site and become the property of the contractor.

END OF SECTION

SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015 (Reaffirmed 2020).
B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2017.
C. NEMA MG 00001 - Motors and Generators; 2024.
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Closeout Documents:
   1. 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. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Allis Chalmers
B. Baldor Electric Company/ABB Group: www.baldor.com.
C. Emerson
D. General Electric
E. Marathon
F. Regal-Beloit Corporation (Century): www.centuryelectricmotor.com.
G. Reliance

H. Westinghouse

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service:
   1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
   2. Motors Larger than 1/2 Horsepower:208/3P , 60 Hz

B. Nominal Efficiency:
   1. Efficiency of all motors: Premium Efficiency Motors with minimum efficiencies as listed in Independence and Security Act (EISA) o f2007 and EPAct standards.

C. Construction:
   1. Open drip-proof type except where specifically noted otherwise.
   2. Design for continuous operation in 104 degrees F environment.
   3. Design for temperature rise in accordance with NEMA MG 00001 limits for insulation class, service factor, and motor enclosure type.
   4. Motors with frame sizes 254T and larger: Energy efficient type.

D. Explosion-Proof Motors: UL approved and labelled for hazard classification, with over temperature protection.

E. 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.

F. 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 threaded conduit connection in end frame.

2.3 APPLICATIONS

A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.

B. Motors located in explosion proof environments and dust collection systems: Totally enclosed type explosion proof.

C. Motors located in exterior locations, air cooled condensers, humidifiers, direct drive axial fans, and roll filters: Totally enclosed type.

D. Motors located in outdoors, in wet air streams downstream of sprayed coil dehumidifiers, in draw through cooling towers, and in humidifiers: Totally enclosed weatherproof epoxy-treated type.

E. Motors driven by Variable Frequency Drives shall in be listed for the application.

2.4 SHAFT GROUNDING

A. All motors over 1 HP on variable frequency drives shall be equipped with shaft grounding system to discharge shaft voltage potential to ground. Motors on variable frequency drives shall be bonded from the motor foot to system ground with high frequency grounding strap consisting on tinned, copper strap with terminations to accommodate the motor foot and system ground.

2.5 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.6 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.7 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Design, Construction, Testing, and Performance: Comply with NEMA MG 00001 for Design B motors.

D. Insulation System: NEMA Class B or better.

E. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

F. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

G. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 26 29 13.

H. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

I. Sound Power Levels: To NEMA MG 00001.

J. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

K. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

L. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

2.8 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. . Electronically Commutated Motor

1. Motor to be a DC electronic commutation type motor (ECM) specifically designed for application.
2. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
3. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
4. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION

SECTION 22 05 19 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Water meters.
B. Flow meters.
C. Pressure gauges.
D. Thermometers.

1.2 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.
B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014 (Reapproved 2025).
C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).
D. AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case; 2024.
E. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Utility Service Metering: Coordinate and apply Utility Service Provider requirements in terms of meter type, size, physical location, pipe size, upstream/downstream pipe lengths required, and other installation details.

1.4 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Product Data: Provide red-marked product data sheets for each furnished item with associated components and accessories.
C. Project Record Documents: Record actual locations of components and instrumentation.

PART 2 PRODUCTS

2.1 FLOWMETERS (FMD)

A. Manufacturers:
   1. Gerand Engineering: www.gerand.com
   2. Flow Design
   3. Griswold
   4. K.G.
   5. Nexus
   6. Tour & Andersson
   7. Red White Valve Corp.
B. Flow meter fittings on water recirculation lines 1/2" thru 1-1/2" shall be calibrated orifice type with integral tamperproof valve. Flowmeter shall be provided with quick connect couplings. Valves shall be provided with stem extension and port extensions as required for insulation thickness applied.
C. Orifice type flowmeter shall have an accuracy of not less than plus or minus 1 percent of actual flow. Orifice type flowmeter shall have a pressure drop at indicated flow not exceeding 25 inch of water column.

2.2 PRESSURE GAUGES

A. Manufacturers:

1. Dwyer Instruments, Inc: www.dwyer-inst.com.
2. Trerice: www.trerice.com.
3. Moeller Instrument Company, Inc: www.moellerinstrument.com/#sle.
4. Omega Engineering, Inc: www.omega.com/#sle.

B. Pressure Gauges: ASME B40.100 metal case, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.

1. Case: Stainless Steel.
2. Dial Text and Markings: Black color on white background with scaled kPa and psi units.
3. Accuracy: ASME B40.100, adjustable commercial grade (B) with 2 percent at mid-range of span.
4. Scale: Psi.
5. Size: 4-1/2 inch diameter.
6. Gauge Wetted Materials: Stainless steel case and stainless steel socket rated to match process pressure and temperature range.
7. Comply with UL 393 when used for fire protection service or UL 404 when used for compressed gas service.

2.3 THERMOMETERS

A. Manufacturers:

1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
2. Moeller Instrument Company, Inc: www.moellerinstrument.com/#sle.
3. Watts Water Technologies, Inc: www.watts.com/#sle.
4. Weiss Instruments, LLC: www.weissinstruments.com/#sle.
5. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
6. Trerice: www.trerice.com

B. General:

1. Product Compliance: ASTM E1.
2. Lens: Clear polycarbonate, except where stated.
3. Accuracy: One percent, when tested in accordance with ASTM E77, except where stated.
4. Scale: Black markings depicting single scale in degrees F where expected process value falls half-span of standard temperature range.

C. Thermometers shall be light powered digital type with solar panels and LCD digits. Thermometers shall be ABS plastic cased and shall be provided with a calibration adjustment.

1. Size: 9 inch case.
2. Window: Clear Lexan.
3. Accuracy: 2 percent, per ASTM E77.
4. Calibration: Degrees F.

2.4 **THERMOMETER SUPPORTS**

A. Socket/Thermowell: Brass separable sockets/thermowell for thermometer stems with or without extensions as required, and with cap and chain.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install metering products in accordance with manufacturer's instructions for intended fluid type and service.

B. Install flowmeters in accessible locations for adjustment and measurement of device.

C. Install pressure gauges as follows:

1. At Pumps: Place single gauge before strainer, suction side and discharge side.
2. Include gauge cock to isolate each gauge and extend nipples for insulation clearance.
3. Adjust gauges to selected viewing angle, clean thoroughly, and calibrate to zero.

D. Install thermometers as follows:

1. Water Heaters: Place upstream and downstream of heater. Add one on the inlet end when using steam as the water heating medium.
2. Piping: Install thermometers in branch butt weld connection fitting or socket-weld thermowell. Enlarge pipes smaller than 2-1/2 inch to accommodate sockets. Ensure sockets are above insulation clearance.

E. Locate PT (pressure-temperature) test plugs adjacent to control device sockets.

3.2 SCHEDULES

A. Pressure Gauges, Location and Scale Range:
   1. Pumps, 0 to 100 psi.
B. Stem Type Thermometers, Location and Scale Range:
   1. Domestic hot water supply and recirculation, 0 to 200 degrees F.

END OF SECTION

SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Ball valves.
B. Check valves.

1.2 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
E. ASME B31.9 - Building Services Piping; 2020.
F. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2025, with Errata.
G. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications; 2022.
H. AWWA C606 - Grooved and Shouldered Joints; 2022.
I. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
J. NSF 61 - Drinking Water System Components - Health Effects; 2017.
K. NSF 372 - Drinking Water System Components - Lead Content; 2016.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
C. Closeout Documents:
   1. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
   2. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.4 QUALITY ASSURANCE

A. Manufacturer:
   1. Obtain valves for each valve type from single manufacturer.
   2. Company must specialize in manufacturing products specified in this section, with not less than five years of documented experience.
B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
   2. Store valves in shipping containers and maintain in place until installation.
      a. Store valves indoors in dry environment.

PART 2 PRODUCTS

2.1 APPLICATIONS

A. See drawings for specific valve locations.

B. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).

C. Provide the following valves for the applications if not indicated on drawings:

1. Shutoff: Ball.
2. Throttling: Ball.
3. Swing Check: Bronze swing check valves with bronze disc.
4. Swing Check (Pump Outlet):
   a. 2 NPS and Smaller: Bronze swing check valves with bronze disc.
   b. 2-1/2 inch and Larger for Domestic Water: Iron swing check valves with closure control, metal or resilient seat check valves.

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

E. Domestic, Hot and Cold Water Valves, low-lead compliant:

1. 2 inch and Smaller:
   a. Bronze: Provide with solder-joint, threaded, or press-fit ends.
   b. Ball: Two piece, full port, bronze with stainless-steel trim.
   c. Bronze Swing Check: Class 125, bronze disc.
2. 2-1/2 NPS to 4 NPS
   a. Bronze: Provide with solder-joint, threaded, or press-fit ends.
   b. Ball: Two piece, full port, bronze with stainless-steel trim.
   c. Bronze Swing Check: Class 125, bronze disc.

2.2 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 Actuator Types:

1. Hand Lever: Quarter-turn valves 6 NPS and smaller.

D. Insulated Piping Valves: With 2 inch stem extensions and the following features:

1. 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.

E. Valve-End Connections:

1. Threaded End Valves: ASME B1.20.1.
2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
3. Pipe Flanges and Flanged Fittings 1/2 inch through 24 inch: ASME B16.5.
4. Solder Joint Connections: ASME B16.18.
5. Grooved End Connections: AWWA C606.

F. General ASME Compliance:

1. Solder-joint Connections: ASME B16.18.
2. Building Services Piping Valves: ASME B31.9.

G. Potable Water Use:
   1. Certified: Approved for use in compliance with NSF 61 and NSF 372.
   2. Lead-Free Certified: Wetted surface material includes less than 0.25 percent lead content.
H. Source Limitations: Obtain each valve type from a single manufacturer.
I. Press-Fit Valve Manufacturers:
   1. Watts
   2. Viega
   3. Milwaukee
   4. Apollo
   5. NIBCO
J. Valve manufacturers unless otherwise noted:
   1. Apollo
   2. NIBCO
   3. Milwaukee
   4. Watts

2.3 BRONZE, BALL VALVES

A. General:
   1. Fabricate from dezincification resistant material.
   2. Copper alloys containing more than 15 percent zinc are not permitted.
B. Two Piece, Full Port with Stainless Steel trim.
   1. WSP Rating: 150 psi.
   2. WOG Rating: 600 psi.
   3. Body: Forged bronze or dezincified-brass alloy.
   4. Ends Connections: Pipe thread or solder.
   5. Seats: PTFE.
   6. Stem: Stainless steel, blowout proof.
   7. Ball: Stainless steel.
   8. Operator: Provide lockable handle and stem extension.

2.4 BRONZE, SWING CHECK VALVES

A. General:
   1. Fabricate from dezincification resistant material.
   2. Copper alloys containing more than 15 percent zinc are not permitted.
B. Class 150: CWP Rating: 300 psig (2070 kPa).
   1. Pressure and Temperature Rating: MSS SP-80, Type 3.
   2. Design: Y-pattern, horizontal or vertical flow.
   3. Body: Bronze, ASTM B584
   4. End Connections: Threaded.
   5. Disc: Bronze.

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. Should valve is determined to be defective, replace with new valve.

3.2 INSTALLATION

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

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

C. Install check valves where necessary to maintain direction of flow as follows:

1. Swing Check: Install horizontal maintaining hinge pin level.

D. Install check valves at least 5 pipe diameters from pumps or changes in direction.

END OF SECTION

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Nameplates.
B. Tags.
C. Pipe markers.
D. Underground warning tape.
E. Ceiling tacks.

1.2 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Product Data: Provide manufacturers catalog literature for each product required.
C. Closeout Documents:
   1. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
      a. Submit plumbing component identification schedule listing equipment, piping, and valves.
      b. Detail proposed component identification data in terms of of wording, symbols, letter size, and color coding to be applied to corresponding product.
      c. Valve Data Format: Include id-number, location, function, and model number.
   2. Project Record Documents: Record actual locations of tagged valves.
D. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.1 PLUMBING COMPONENT IDENTIFICATION GUIDELINE

A. Nameplates:
   1. Water heaters, and other heat transfer products.
   2. Control panels, transducers, and other related control equipment products.
   3. Pumps, tanks, filters, water treatment devices, and other plumbing equipment products.
B. Tags:
   1. Piping: 3/4 inch diameter and smaller.
   2. Manual operated and automated control valves.
   3. Instrumentation, relays, gauges, and other related control equipment products.
C. Pipe Markers: 3/4 inch diameter and higher.

2.2 NAMEPLATES

A. Manufacturers:
   1. Brimar Industries, Inc: www.pipemarker.com/#sle.
   2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
   3. Seton Identification Products: www.seton.com.
B. Description: Laminated piece with up to three lines of text.

1. Letter Color: Black.
2. Letter Height: 1/2 inch.
3. Background Color: Green.
4. Nameplate Height: 3/4 inch.

2.3 TAGS

A. Manufacturers:
1. Advanced Graphic Engraving: www.advancedgraphicengraving.com.
2. Brady Corporation: www.bradycorp.com/#sle.
3. Brimar Industries, Inc.: www.pipemarker.com/#sle.
4. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
5. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
6. Seton Identification Products: www.seton.com.

B. Flexible: Vinyl with engraved black letters on light contrasting background color with up to three lines of text. Minimum tag size 1-1/2 inch in diameter.

C. Metal: Brass, 19 gauge 1-1/2 inch in diameter with smooth edges, blank, smooth edges, and corrosion-resistant ball chain. Up to three lines of text.

D. Valve Tag Chart: Typewritten 12-point letter size list in anodized aluminum frame.

E. Piping: 3/4 inch diameter and smaller. Include corrosion resistant chain. Identify service, flow direction, and pressure.

2.4 PIPE MARKERS

A. Manufacturers:
1. Brady Corporation: www.bradycorp.com.
2. Brimar Industries, Inc: www.pipemarker.com/#sle.
3. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
5. Seton Identification Products: www.seton.com.

B. Comply with ASME A13.1.

C. Flexible Marker: Factory fabricated, semi-rigid, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid conveyed.

D. Flexible Tape Marker: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

E. Underground Flexible Marker: Bright-colored continuously printed ribbon tape, minimum 6 inches wide by 4 mil, 0.004 inch thick, manufactured for direct burial service.

F. Identification Scheme, ASME A13.1:
1. Primary: External Pipe Diameter, Uninsulated or Insulated.
a. 3/4 to 1-1/4 inches: Use 8 inch field-length with 1/2 inch text height.
b. 1-1/2 to 2 inches: Use 8 inch field-length with 3/4 inch text height.
c. 2-1/2 to 6 inches: Use 12 inch field-length with 1-1/4 inch text height.
d. 8 to 10 inches: Use 24 inch field-length with 2-1/2 inch text height.
e. Over 10 inches: Use 32 inch field-length with 3-1/2 inch text height.

2. Secondary: Color scheme per fluid service.
a. Water; Potable, Cooling, Boiler Feed, and Other: White text on green background.

3. Tertiary: Other Details.

a. Directional flow arrow band over pipe circumference.

2.5 UNDERGROUND WARNING TAPE

A. Manufacturers:
1. Brady Corporation: www.bradyid.com/#sle.
2. Brimar Industries, Inc: www.brimar.com/#sle.
3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
4. Seton Identification Products: www.seton.com/#sle.

B. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
1. Exception: Use foil-backed detectable type tape where required by serving utility.

C. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil, 0.004 inch.

D. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, 0.005 inch, unless otherwise required for proper detection.

E. Legend: Type of service, continuously repeated over full length of tape.

F. Color:
1. Tape for Buried Power Lines: Black text on red background.
2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.6 CEILING TACKS

A. Manufacturers:
1. Craftmark: www.craftmarkid.com.
2. Seton Identification Products: www.seton.com.

B. Description: Steel with 3/4 inch diameter color coded head.

C. Color code as follows:
1. Plumbing Equipment: Yellow.
2. Plumbing Valves: Green.

2.7 **CEILING IDENTIFICATION TAGS**

A. All plumbing valves shall be denoted with a small engraved tag, attached to the ceiling below the device. The tag shall be white engraved lettering, containing the numbered nomenclature used for the device on the mechanical schedules/drawings.

B. Manufacturers:
1. Brady Corporation: www.bradycorp.com.
2. Brimar Industries, Inc: www.pipemarker.com/#sle.
3. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
5. Seton Identification Products: www.seton.com.

C. Markers:
1. Use colored markers with pressure sensitive adhesive on one side.
2. Make colored markers of plastic, 3/4 to 1 inch in wide by 2-1/2 to 3 inch long.
3. Use markers of the same size throughout building.
4. Color Code: Use following color markers for service identification:
a. Domestic Water: Valves and Controls - White on Green

b. Gas: Laboratory, Medical, Air and Vacuum Valves - Black on White

PART 3 EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive identification products.

3.2 INSTALLATION

A. All new piping shall be identified as to contents and direction of flow by stenciling or markers, as specified. Apply where pipes pass through walls (both sides of the wall), at each change of direction and on each 20 feet of straight lengths. For insulated pipe, stencil/marker size shall be based on insulation size, not pipe size.
   1. Identify service, flow direction, and pressure.
   2. Install in clear view and align with axis of piping.

B. Piping shall be identified as to contents using the following list. Additional system details shall be included within this specification section.

Cold Water	C.W.
120° F Hot Water	H.W.
Recirculating Hot Water	R.H.W.
Sanitary Drain	SAN. DRAIN
Storm Drain	STORM DRAIN
Sanitary Vent	SAN. VENT

C. Valves controlling mains, risers and branches, but not individual shut-off or local control valves on fixtures and equipment, shall be identified by a metal tag Schedules, framed under glass and mounted where directed, shall be provided showing a complete listing of all valve tags and giving numbers, locations, and color codes, if any, of pipes controlled. Frames shall be secured to wall by not less than four screws.Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

D. Install tags in clear view and align with axis of piping.

E. Install plastic tape pipe marker around pipe in accordance with manufacturer's instructions.

F. Apply ASME A13.1 Pipe Marking Rules:
   1. Place pipe marker adjacent to changes in direction.
   2. Place pipe marker adjacent each valve port and flange end.
   3. Place pipe marker at both sides of floor and wall penetrations.
   4. Place pipe marker every 20 feet interval of straight run.

G. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 22 07 19 - PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Glass fiber insulation.

B. Jacketing and accessories.

1.2 REFERENCE STANDARDS

A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019, with Editorial Revision (2023).

B. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2025.

C. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2022a.

D. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

F. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.

G. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.

B. Shop Drawings:

1. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.4 QUALITY ASSURANCE

A. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum five years of experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.6 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 GLASS FIBER INSULATION

A. Manufacturers:

1. CertainTeed Corporation: www.certainteed.com.
2. Johns Manville Corporation: www.jm.com.
3. Knauf Insulation: www.knaufusa.com.

4. Owens Corning Corporation: www.ocbuildingspec.com/sle.

B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
1. K Value: ASTM C177, 0.24 at 75 degrees F.
2. Maximum Service Temperature: 850 degrees F.
3. Maximum Moisture Absorption: 0.2 percent by volume.

C. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm.

D. Vapor Barrier Lap Adhesive: Compatible with insulation.

2.3 **FLEXIBLE ELASTOMERIC CELLULAR INSULATION**

A. Manufacturers:
1. Aeroflex USA, Inc: www.aeroflexusa.com.
2. Armacell LLC: www.armacell.us.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
1. Maximum Service Temperature: 220 degrees F.
2. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.4 JACKETING AND ACCESSORIES

A. PVC Plastic Jacket:
1. Manufacturers:
a. Johns Manville Zeston 2000 Series White PVC or equal.

2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
a. Minimum Service Temperature: 0 degrees F.

b. Maximum Service Temperature: 150 degrees F.

c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.

d. Thickness: 10 mil, 0.010 inch.

e. Connections: Brush on welding adhesive.

3. Covering Adhesive Mastic: Compatible with insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Hot Lines with Glass Fiber Insulation:
1. Pipe - Butt all side and end joints tightly and apply a brush coat of fire retardant lagging adhesive to all laps and joint strips. Seal laps, pulling jacketing tight and smooth. Self sealing laps shall be secured according to manufacturers published recommendations. Open ends of pipe insulation shall be neatly stopped off and tapered down with insulating cement and covered with canvas embedded into a wet coat of fire retardant lagging adhesive.

2. Fittings - All fittings shall be insulated with segments of glass fiber pipe insulation or loops of insulating blocks firmly held in place with #16 galvanized soft wire. Cover all fitting insulation with Zeston, or equal, white plastic fitting covers.
3. Valves Etc. - All valve bodies, strainers and flanges shall be insulated as specified for fittings.

C. Cold Lines with Glass Fiber Insulation:
1. Pipe - Butt all side and end joints tightly and apply a brush coat of fire retardant lagging adhesive to all laps and joint strips. Seal laps, pulling jacketing tight and smooth. Ends of pipe insulation shall be sealed with a fire retardant vapor barrier coating at all fittings and valves, and at intervals of 21 feet on continuous runs of pipe. Self sealing laps shall be secured according to manufacturers published recommendations.
2. Insulation, vapor barrier and covering shall be continuous through all domestic cold water pipe supports and pipe sleeves.
3. Fittings - All fittings shall be insulated with molded fiber glass fittings, segments of pipe covering, or with compressed flexible glass fiber secured in place with non-corrosive wire. All thicknesses to be equal to that of adjoining pipe covering. Cover all fitting insulation with Zeston, or equal, white plastic fitting covers. If batt type insulation is used, it must be a minimum of 1 pound density and 1 inch thick.
4. Valves Etc. - All valve bodies, strainers and flanges shall be insulated as specified for fittings.

D. Cold Lines with Flexible Elastomeric Foam Insulation
1. Insulation Installation on Straight Pipes and Tubes:
   a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

   b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

   c. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inch on center.

   d. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

2. Insulation Installation on Pipe Flanges:
   a. Install preformed pipe insulation to outer diameter of pipe flange.

   b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

   c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.

   d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

3. Insulation Installation on Pipe Fittings and Elbows:
   a. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

   b. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

4. Install preformed sections of cellular-glass insulation to valve body.
   a. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

   b. Install insulation to flanges as specified for flange insulation application.

E. Roof Drain Sumps - Roof drain sumps shall be insulated as specified for fittings.

F. Apply PVC jackets with longitudinal seams and end joints overlapping at least 2 inch. Seal weather tight with manufacturers recommended sealant. Apply the jacket such that the longitudinal seam is on the bottom of pipe.

G. Exposed Piping: Locate insulation and cover seams in least visible locations.

H. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, storage tanks, pump bodies, and expansion joints.

I. Insulate sump pump discharge lines from sump pit to wall where discharge line leaves the building.

J. Insulate all above grade cooling coil condensate discharge lines. This shall include, but not be limited to air handler, fan coil, furnace, and heat pump cooling coils.

K. Insulate floor drain sumps and all horizontal sanitary waste pipe and fittings for all floor drains above grade receiving cooling coil condensate. Insulate horizontal sanitary waste line from floor drain to nearest vertical sanitary riser.

L. Install insulation with factory-applied jackets with a manufacturer-approved adhesive along seams, both straight lap joints and circumferential lap joints.
   1. Inserts and Shields:
      a. All domestic piping 1-1/2 inch and smaller, no insert is required below the insulation. Saddles shall be provided for all insulated piping. Both inserts and saddles shall be provided for all piping 2 inch and larger.

      b. On domestic water, a pipe insulation protection saddle of 22 gauge galvanized sheet metal for piping 3 inch diameter and smaller, and 18 gauge for piping larger than 3 inch diameter, shall be provided at supports where pipe is supported by the insulation or inserts. The saddle shall be at minimum length of 12 inch.

      c. Pipe supports for piping which operates below 250°F shall made be high density phenolic foam pipe insulation similar to Tru-Balance 2550FS saddles as manufactured by Buckaroos, Inc. Insulation in saddles shall meet ASTM E-84 ratings for 25/50 flame/smoke spread.

   2. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 84 00.
   3. Apply a PVC jacket to all exposed piping below 8' above finished floor in ALL rooms or spaces where occupants or staff can enter.

M. Equipment Insulation:
   1. Water meter shall be insulated with 3/4 inch thick Armaflex II foam sheet insulation. Insulation edges shall be cut straight and all joints adhered using an approved adhesive. Insulation shall be cut and formed to match the contour of the water meter. Insulation shall be installed to minimize any void between the insulation and water meter. Installation of insulation shall be a neat workmanlike manner.
   2. Insulation shall not be applied over equipment nameplates or ASME stamps. Bevel and seal insulation around such locations.

3.3 SCHEDULES

A. Plumbing system glass fiber insulation sizes:

Service	Pipe Size	Insulation Thickness
Cold water	1-1/4 inch and less	1/2 inch
Cold water	1-1/2 inchand greater	1 inch
Rainleaders	All sizes	1 inch
Hot water (105F to 140F)	1 inch and less	1 inch
Hot water (105F to 140F)	1-1/4 inchto 1-1/2 inch	1-1/2 inch
Hot water (105F to 140F)	2 inch and greater	2 inch

B. 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, but not to a thickness less than 1”.

END OF SECTION

SECTION 22 10 05 - PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Sanitary waste piping, buried within 5 feet of building.
B. Sanitary waste piping, above grade.
C. Domestic water piping, above grade.
D. Storm drainage piping, buried within 5 feet of building.
E. Storm drainage piping, above grade.
F. Pipe flanges, unions, and couplings.
G. Pipe hangers and supports.
H. Pressure relief valves.

1.2 REFERENCE STANDARDS

A. ANSI Z21.22 - American National Standard for Relief Valves for Hot Water Supply Systems; 2015 (Reaffirmed 2020).
B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
D. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes; 2024.
E. ASME B31.9 - Building Services Piping; 2020.
F. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2025, with Errata.
G. ASSE 1003 - Water Pressure Reducing Valves for Potable Water Distribution Systems; 2023.
H. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
I. ASTM B32 - Standard Specification for Solder Metal; 2020.
J. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes; 2025.
K. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2020.
L. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
M. ASTM B813 - Standard Specification for Water Flushable Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2024.
N. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.
O. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2020a.
P. ASTM C1277 - Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.
Q. ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings; 2020.
R. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020 (Reapproved 2024).
S. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2025.
T. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020 (Reapproved 2024).

U. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2024, with Editorial Revision (2025).
V. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.
W. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2023.
X. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2023.
Y. AWWA C550 - Protective Interior Coatings for Valves and Hydrants; 2024.
Z. AWWA C606 - Grooved and Shouldered Joints; 2022.
AA. AWWA C651 - Disinfecting Water Mains; 2023.
BB. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.
CC. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2020.
DD. FM 1680 - Examination Standard for Couplings Used in Hubless Cast Iron Systems for Drain, Waste or Vent, Sewer, Rainwater or Storm Drain Systems Above and Below Ground, Industrial/ Commercial and Residential; 2025.
EE. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2018, with Editorial Revision (2020).
FF. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).
GG. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .
HH. NSF 61 - Drinking Water System Components - Health Effects; 2017.
II. NSF 372 - Drinking Water System Components - Lead Content; 2016.
JJ. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
    1. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
    2. Welder Certificate: Include welders certification of compliance with ASME BPVC-IX.
C. Closeout Documents:
    1. Project Record Documents

1.4 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.
B. Valves: Manufacturer's name and pressure rating marked on valve body.
C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.6 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

B. Plenum-Installed Acid Waste Piping: Flame-spread index equal or below 25 and smoke-spread index equal or below 50 according to ASTM E84 or UL 723 tests.

2.2 SANITARY WASTE PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe (epoxy coated): CISPI 301, hubless.
   1. Fittings: Cast iron (epoxy coated.
   2. Joints: CISPI 310, neoprene gasket and heavy duty stainless steel clamp and shield assemblies.
   3. Provide on-site coating of cut edges equal to PPG Multi-Prime 4160 or Fast Dry 4180 coating following all manufacturer instructions.

B. PVC Pipe: ASTM D2665
   1. Fittings: PVC
   2. Joints: Solvent welded, ASTM D2665 with solvent cement

2.3 SANITARY WASTE PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, ASTM A888 hubless,.
   1. Fittings: Cast iron.
   2. Joints: ASTM C1540 neoprene gaskets heavy-duty stainless steel clamp-and-shield assemblies. For vent piping, provide neoprene gaskets with standard duty stainless steel clamp-and-shield assemblies.

B. PVC Pipe: ASTM D2665.
   1. Fittings: PVC.
   2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.4 **DOMESTIC WATER PIPING, BURIED WITHIN 5-FEET OF BUILDING**

A. Copper Pipe: ASTM B42, type K, annealed.
   1. No fittings below grade.

B. Ductile Iron Pipe: AWWA C151/A21.51.
   1. Fittings: Ductile or gray iron, standard thickness.
   2. Joints: AWWA C111/A21.11, styrene butadiene rubber (SBR) or vulcanized SBR gasket with 3/4 inch diameter rods.

2.5 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tube: ASTM B88, (ASTM B88M), 1 1/2 inch and smaller shall be Type L hard drawn copper. Tubing 2 inch and larger shall be Type M hard drawn copper. Soft drawn copper tubing in small sizes may be used adjacent to fixtures and equipment.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Joints: ASTM B32, alloy Sn95 solder.
   3. Mechanical Press Sealed Fittings: Double-pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements.
      a. Manufacturers:
         1) Apollo Valves: www.apollovalves.com/#sle.

2) Viega LLC: www.viega.com.

3) Nibco

4) Milwaukee

2.6 STORM DRAINAGE PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
1. Fittings: Cast iron.
2. Joints: Neoprene gaskets and heavy-duty stainless steel clamp-and-shield assemblies.

B. PVC Pipe: ASTM D2665.
1. Fittings: PVC.
2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.7 STORM DRAINAGE PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
1. Fittings: Cast iron.
2. Joints: Neoprene gaskets and heavy-duty stainless steel clamp-and-shield assemblies.

B. PVC Pipe: ASTM D2665.
1. Fittings: PVC.
2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.8 PIPE FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 inch and Under:
1. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Sizes Over 1 inch:
1. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
1. Dimensions and Testing: In accordance with AWWA C606.
2. Housing Material: Provide ASTM A47/A47M malleable iron or ductile iron, galvanized.
3. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
4. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
5. When pipe is field grooved, provide coupling manufacturer's grooving tools.
6. Manufacturers:
a. Victaulic - Style 606.

D. No-Hub Couplings (Sanitary Vent Piping Only):
1. Testing: In accordance with ASTM C1277 and CISPI 310.
2. Gasket Material: Neoprene complying with ASTM C564.
3. Clamp: Type 304 Stainless Steel.
4. Band Material: Type 304 Corrugated Stainless steel (0.010-inch thick).
5. Screw Material: Type 305 or 304L Stainless steel (5/16").
6. Manufacturers:
a. Husky SD-2000.

b. Substitutions: See Section 01 60 00 - Product Requirements.

E. Shielded, Heavy Duty No-Hub Couplings:
1. Testing: In accordance with ASTM C1540 and FM 1680.
2. Gasket Material: Neoprene complying with ASTM C564.

3. Clamp: Type 304 Stainless Steel.
4. Band Material: Type 304 Corrugated Stainless steel (0.015-inch thick).
5. Screw Material: Type 305 or 304L Stainless steel (3/8").
6. Manufacturers:
   a. Husky SD-4000.

   b. Substitutions: See Section 01 60 00 - Product Requirements.

F. Shielded, Heavy Duty, Corrosion Resistant No-Hub Couplings (for use with epoxy coated cast iron piping):
1. Testing: In accordance with ASTM C1540.
2. Gasket Material: Neoprene complying with ASTM C564.
3. Clamp: Type 316 Stainless Steel.
4. Band Material: Type 316 Corrugated Stainless steel (0.015-inch thick).
5. Screw Material: Type 316 Stainless steel (3/8").
6. Manufacturers:
   a. Husky CR-7000.

   b. Substitutions: See Section 01 60 00 - Product Requirements.

G. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.9 PIPE HANGERS AND SUPPORTS

1. Manufacturers:
   a. Anvil

   b. Erico-Caddy

2. Hangers and strut located in corrosive areas shall be type 316 stainless steel with stainless steel hardware.
3. Hangers for all piping shall be oversized to encircle the piping and the insulation, the insulation shall be continuous through all hangers.
   1) Cold and Hot Pipe Sizes 6 inch and Larger: Double hangers.

   b. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.

B. Plumbing Piping - Drain, Waste, and Vent:
1. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Carbon steel, adjustable swivel, split ring.
2. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
3. Hanger Rods: Zinc-plated steel, threaded both ends, threaded one end, or continuous threaded.
4. Wall Support for Pipe Sizes to 3 inch: Cast iron hook.
5. Wall Support for Pipe Sizes 4 inch and Over: Welded steel bracket and wrought steel clamp.
6. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
7. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Plumbing Piping - Water:
1. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Carbon steel, adjustable swivel, split ring.
2. Hangers for Cold Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
3. Hangers for Hot Pipe Sizes 2 to 4 inch: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 6 inch and Larger: Adjustable steel yoke, cast iron pipe roll, double hanger.
5. Hanger Rods: Zinc-plated steel, threaded both ends, threaded one end, or continuous threaded.
6. Wall Support for Pipe Sizes Up to 3 inch: Cast iron hook.

7. Wall Support for Pipe Sizes 4 inch and Larger: Welded steel bracket and wrought steel clamp.
8. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Floor Support for Hot Pipe Sizes to 4 inch: Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
10. Copper Pipe Support: Carbon steel ring, adjustable, copper plated for uninsulated copper pipe.

D. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
1. Concrete Wedge Expansion Anchors: Comply with ICC-ES AC193.
2. Masonry Wedge Expansion Anchors: Comply with ICC-ES AC01.

2.10 PRESSURE RELIEF VALVES

A. ANSI Z21.22, AGA certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.

2.11 STRAINERS

A. Manufacturers:
1. Titan Flow Control, Inc.: www.titan.com

B. Size 2 inch and Smaller:
1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
2. Class 125, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 1-1/2 inch to 4 inch:
1. Class 125, flanged ductile iron body (epoxy coated), Y pattern with 1/32 inch stainless steel perforated screen.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Remove scale and dirt, on inside and outside, before assembly.

B. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. The contractor shall note plastic pipe is not allowed above the ceilings in any areas that are used as return air plenums.

C. Plastic DWV piping shall be installed as addressed by IAPMO (UPC) section on Expansion and Contraction. Any straight runs of plastic DWV piping exceeding 30 feet shall be installed to accommodate thermal expansion.

D. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

E. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

F. Install piping to maintain headroom, conserve space, and not interfere with use of space.

G. Group piping whenever practical at common elevations.

H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 22 05 16.

I. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
1. See Section 22 07 19.

J. Provide access where valves and fittings are not exposed.

K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.

L. Provide support for utility meters in accordance with requirements of utility companies.

M. Prepare exposed, unfinished pipe, fittings, supports, and accessories for finish painting.

1. All exposed gas piping outdoors shall be cleaned of all dirt, grease and oil, painted with one coat primer and two coats enamel of a color to be selected by the architect. If steel piping is used, a second option shall be galvanized in lieu of painting.

N. Excavation, Trenching, and Backfilling

1. Excavation and Trenching: The bottom of trenches shall be tamped hard and graded to secure required fall. Bell holes shall be excavated so that pipe shall rest on solid ground for its entire length. Rock, where encountered, shall be excavated to a depth of six (6) inches below the bottom of the pipe, and before pipe is laid, the space between the bottom of the pipe and the rock surface shall be filled with gravel. All surplus excavating materials shall be removed from the job site to location directed by the Architect.
2. Filling and Backfilling - Interior: At areas below concrete floor slab on ground, a sandy loam backfill shall be placed in 6" layers and thoroughly compacted by approved means at optimum moisture to a density of 95% or Standard Proctor Density. Sandy loam fill shall contain not more than 10% of clay and/or silt. Fill shall not contain gravel particles larger than 1/2". Material for backfill shall be approved by Architect and by an approved testing laboratory.
3. Tests shall be made at expense of the Contractor by an approved testing laboratory, to determine adequacy of compaction. These tests shall be made during the compaction operation at various levels to insure uniformity of compaction and test reports shall show elevation as well as location of tests. The testing laboratory inspector shall be on the site at intervals during all major backfilling operations. Compaction tests shall be made at locations as directed by Architect.
4. Cracked and/or damaged floor slabs, walls or partitions resulting from improper compaction of fill materials shall be repaired or replaced, as directed by Architect, at the Contractor's expense.

O. Install valves with stems upright or horizontal, not inverted. See Section 22 05 23.

P. Install water piping to ASME B31.9.

Q. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.

R. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

S. Sleeve pipes passing through partitions, walls, and floors.

T. Inserts:

1. Provide inserts for placement in concrete formwork.
2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

U. Pipe Hangers and Supports:

1. Install in accordance with ASME B31.9.
2. Support horizontal piping as per local plumbing codes.
3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
4. Place hangers within 12 inches of each horizontal elbow.
5. Hangers shall not be placed on couplings.
6. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
7. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
8. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

9. Provide copper plated hangers and supports for copper piping.
10. Provide stainless steel hangers and rods for piping installed in corrosive environments (ie. swimming pools, green houses, etc.).
11. Support cast iron drainage piping at every joint within 18 inches.
12. All hangers shall be oversized to encircle the piping and the insulation. Insulation shall be continuous through all hangers.

V. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.4 APPLICATION

A. Use grooved mechanical couplings and fasteners only in accessible locations.

B. Install unions downstream of valves and at equipment or apparatus connections.

C. Provide spring-loaded check valves on discharge of water pumps.

D. Provide flow controls in water recirculating systems where indicated.

E. Piping installed in ventilation plenums

1. In all cases, product and piping assembly shall meet flame and smoke spread ratings of 25/50
2. Cast Iron

F. High Temperature Water (130 degrees F and higher)

1. Waste from commercial kitchens, boiler blowdown, steam humidifiers, etc. shall be cast iron or CPVC similar to SPEARS lab waste and fittings as herein specified. These drain lines may be connected to PVC waste lines where a continuous flow of cold water is present to blend with the hot waste or as indicated on drawings.

3.5 TOLERANCES

A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Disinfect water distribution system in accordance with Division 33.

B. Prior to starting work, verify system is complete, flushed, and clean.

C. Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

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

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

H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.7 SERVICE CONNECTIONS

A. Provide new sanitary and storm sewer services. Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service complete with approved water meter with by-pass valves. Meter size based on 120 gpm and 2 psi pressure drop.

1. Provide schd. 40 steel sleeve in wall for service main and support at wall. Provide LINK-SEAL in sleeve at wall penetration. Anchor service line inside to concrete wall.

END OF SECTION

SECTION 22 10 06 - PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Drains.
B. Cleanouts.
C. Hose bibbs.
D. Hydrants.
E. Washing machine outlet boxes.
F. Ice maker outlet boxes.
G. Water hammer arrestors.
H. Sanitary waste interceptors.
I. Relief valves.

1.2 REFERENCE STANDARDS

A. ASME A112.6.3 - Floor Drains; 2022.
B. ASME A112.6.4 - Roof, Deck, and Balcony Drains; 2022.
C. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers; 2023.
D. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance; 2023.
E. DIN 19580 - Drainage Channels for Vehicular and Pedestrian Areas - Durability, Mass Per Unit Area and Evaluation of Conformity; 2010.
F. NSF 61 - Drinking Water System Components - Health Effects; 2017.
G. NSF 372 - Drinking Water System Components - Lead Content; 2016.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
    1. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
    2. SIndicate dimensions, weights, and placement of openings and holes.
    3. Certificates: Certify that grease interceptors meet or exceed specified requirements.
C. Closeout Documents:
    1. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
D. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, and water hammer arrestors.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

2.2 DRAINS

A. Manufacturers:
   1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
   2. Josam Company: www.josam.com.
   3. MIFAB, Inc: www.mifab.com/#sle.
   4. Zurn Industries, LLC: www.zurn.com.
   5. Watts
   6. Wade

B. Roof Drains:
   1. Assembly: ASME A112.6.4.
   2. Body: Lacquered or factory-coated cast iron with sump.
   3. Strainer: Removable polyethylene or cast metal dome with vandal proof screws.
   4. Accessories: Coordinate with roofing type:
      a. Membrane flange and membrane clamp with integral gravel stop.
      b. Adjustable four bolt under deck clamp with stainless steel bolts and nuts.
      c. Adjustable under deck clamp.
      d. Roof sump receiver.
      e. Waterproofing flange.
      f. Controlled flow weir.
      g. Leveling frame.
      h. Adjustable extension sleeve for roof insulation.
      i. Perforated stainless steel ballast guard extension in green roofs.
      j. Overflow roof drains to be provided with 2" collar.
         1) Provide with 4" collar where indicated.

C. Downspout Nozzles:
   1. Bronze round with straight bottom section.

D. Floor Drain FD:
   1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, square adjustable nickel-bronze strainer and separate deep seal trap. For floor drains in mechanical rooms, provide a round drain with recessed strainer.

E. Emergency Floor Drain:
   1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, square, adjustable nickel-bronze strainer and separate deep seal trap, provide trap seal.

F. Prefabricated Trench Drain (TD): Trench drain system assembled from factory fabricated, High Density Polyethylene (HDPE) in standard lengths and variable depths, with integral joint flanges and integral grating support rails; includes joint gaskets and grating.
   1. Basis of Design: Zurn Z-886-HD (6-3/4" Grate/4" Internal throat):
   2. Load Class: DIN EN1433, Class C.
   3. Grating Material and Style: Longitudinally slotted ductile iron.
   4. Manufacturers:
      a. Mifab

b. JR Smith

c. Watts

d. Zurn

5. Accessories:
   a. Oval to round pipe connection.

   b. Vertical outlet strainer.

G. Floor Sink :

1. Square lacquered cast iron body with integral seepage pan, epoxy coated interior, aluminum dome strainer, sediment bucket, half grate. Provide separate deep seal trap.

2.3 CLEANOUTS

A. Manufacturers:

1. Jay R. Smith Manufacturing Company: www.jayrsmith.com.
2. Josam Company: www.josam.com.
3. MIFAB, Inc: www.mifab.com/#sle.
4. Zurn Industries, LLC: www.zurn.com.
5. Wade.
6. Watts

B. Cleanouts at Exterior Surfaced Areas:

1. Round cast nickel bronze access frame and non-skid cover.

C. Cleanouts at Exterior Unsurfaced Areas:

1. Line type with lacquered cast iron body and round epoxy coated gasketed cover.

D. Cleanouts at Interior Finished Floor Areas:

1. Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.

E. Cleanouts at Interior Finished Wall Areas:

1. Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.

F. Cleanouts at Interior Unfinished Accessible Areas:

1. Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

G. Interal plugs shall be constructed of brass, PVC or ABS.

2.4 HOSE BIBBS

A. Manufacturers:

1. Jay R. Smith Manufacturing Company: www.jrsmith.com/#sle.
2. Watts Regulator Company: www.wattsregulator.com/#sle.
3. Zurn Industries, LLC: www.zurn.com.
4. Chicago

B. Interior Hose Bibbs:

1. Bronze or brass with mounting flange, replaceable seat, hose thread spout, and integral or add-on vacuum breaker complying with ASSE 1011.
2. Finishes:
   a. Exposed Locations: Polished chrome.

3. Operation:
   a. Mechanical and Equipment Rooms: Handwheel.

2.5 HYDRANTS

A. Manufacturers:
1. Arrowhead Brass & Plumbing, LLC: www.arrowheadbrass.com/#sle.
2. Jay R. Smith Manufacturing Company: www.jrsmith.com/#sle.
3. Woodford
4. Zurn Industries, LLC: www.zurn.com.
5. Watts.

B. Wall Hydrants, HYD-1:
1. Freeze resistant, self-draining type, Chrome-plated, hose threaded spout, loose tee key, ASSE 1019 approve or with ASSE 1052 testable double check backflow preventer and vacuum breaker.
2. Mounting Style:Wall Plate similar to Woodford Model 67

C. Roof Hydrants, HYD-2 (No Drain Required):
1. ASSE 1057 with ASSE 1052 approved backflow preventer; freeze resistant, self-draining type with roof mounting system consisting of hydrant support, underdeck flange and mounting hardware. 3/4" hose thread outlet and integral vacuum breaker.
2. Similar to Woodford Model SRH-MS.

2.6 WASHING MACHINE TRIM BOXES AND VALVES (WMT-1)

A. Box Manufacturers:
1. IPS Corporation/Guy Gray FRM12SHA Powder Coated Steel: www.ipscorp.com.
2. Oatey Supply Chain Services, Inc: www.oatey.com/#sle.

B. Valve Manufacturers:
1. IPS Corporation[<>]: www.ipscorp.com.
2. Oatey Supply Chain Services, Inc: www.oatey.com/#sle.

C. Description: Metal preformed rough-in box with brass valves with quarter-turn handle, socket for 2 inch waste, slip in finishing cover. Integral water hammer arrestor.

2.7 REFRIGERATOR AND ICE MACHINE TRIM BOXES AND VALCES (IMT-1)

A. Box Manufacturers:
1. IPS Corporation/Guy Gray FRIB12ABSHA High Temperature Resin : www.ipscorp.com
2. Oatey Supply Chain Services, Inc: www.oatey.com/#sle.

B. Valve Manufacturers:
1. IPS Corporation[<>]: www.ipscorp.com.
2. Oatey Supply Chain Services, Inc: www.oatey.com/#sle.

C. Description: High Temperature Resin preformed rough-in box with quarter turn brass valve, slip in finishing cover. Integral water hammer arrestor .

2.8 WATER HAMMER ARRESTORS

A. Manufacturers:
1. Jay R. Smith Manufacturing Company
2. Watts Regulator Company, a part of Watts Water Technologies
3. Zurn
4. Wade
5. Josam
6. Sioux Chief
7. Oatey

B. Water Hammer Arrestors:
1. Shock absorbers shall be constructed with wrought copper, hydro-pneumatic air cushion, dual or triple O-ring sealed piston and threaded wrought copper male inlet.

2.9 SANITARY WASTE INTERCEPTORS

A. Manufacturers:
   1. Schier.
   2. Striem.
   3. ACO.
   4. Midwest Tank.
   5. MIFAB.

B. Grease Interceptors:
   1. Construction:
      a. Material: HDPE.

      b. Rough-in: Fully recessed flush with floor (deep rough-in) with anchor flange.

      c. Cover: HDPE and H20 Rated Pickable Cast Iron, non-skid with gasket, securing handle, and enzyme injection port, recessed for floor finish.

2.10 RELIEF VALVES

A. Manufacturers:
   1. Cash Acme, a brand of Reliance Worldwide Corporation: www.cashacme.com/#sle.
   2. ITT Bell & Gossett: www.bellgossett.com/#sle.

B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Install floor cleanouts at elevation to accommodate finished floor.

E. Where required by code, a cleanout shall be installed above the fixture connection fitting, serving each urinal, regardless of the location of the urinal in the building. Coordinate exact location of each cleanout with the Architect.

F. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.

G. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to water closets, flush valves, solenoid valves, quick closing valves and as indicated on drawings. Provide washing machine trim and ice machine trim boxes with water hammer arrestors.

H. Each floor-set floor drain (e.g., floor drains, shower drains, floor sinks, mop basins) with traps that are not accessible shall be provided with full size cleanouts.

I. Building sewers shall have cleanouts not more than 75' apart for 4" pipe and not more than 100' apart for larger pipe.

J. Provide a cleanout at the connection point of new and existing systems to allow for the testing of all new piping systems. Additional building cleanouts shall be installed at each horizontal change in direction exceeding 135-degrees.

END OF SECTION

SECTION 22 14 29 - SUMP PUMPS

PART 1 GENERAL

1.1 Section Includes

A. Submersible sump pumps.

B. Sump basins and pits.

1.2 Reference Standards

A. ICC (IPC) - International Plumbing Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.3 Submittals

A. See Division 01 - Administrative Requirements for submittal procedures.

B. Shop Drawings: Include dimensions and performance data.

C. Closeout Documents:

1. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
2. Executed warranty.

1.4 Quality Assurance

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section with three years minimum of documented experience.

B. Certifications: UL (DIR) listed, classified, and suitable for the purpose specified and indicated.

C. Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.

1.5 Delivery, Storage, and Handling

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

PART 2 PRODUCTS

2.1 Submersible Sump Pumps

A. Manufacturers:

1. Zoeller Company
2. Weil a WILO Company
3. Liberty Pumps
4. Little Giant

B. General: Cast iron housing and base with oil-filled motor chamber, ball bearings, and mechanical seal.

C. Type: Completely submersible, vertical, centrifugal.

D. Impeller: Cast iron; open nonclog, stainless steel shaft.

E. Motor: Base mount, enclosed, lubricated oil-free, thermal-overload protected, continuous duty, permanent split capacitor with oil-resistant, three-prong connector, 10 foot power cord.

F. Controls: Motor control panel containing across-the-line electric motor starters with ambient compensated quick trip overloads in each phase with manual trip button and reset button, circuit breaker, control transformer, electro mechanical alternator, hand-off-automatic selector switches, pilot lights, high water alarm pilot light, reset button and alarm horn. Provide mercury switch liquid level controls, steel shell switch encased in polyurethane foam with cast iron weight for pump on each pump, pump off, and alarm. Provide auxiliary contacts for alarm monitoring by Building Automation System.

G. Solids Handling Capacity: Pass lint and other small solids up to 1/2 inch in size.

H. Discharge Pipe Size: 2 inch, NPT, female.

I. Maximum Water-Based Effluent Temperature: 120 degrees F.

J. Accessories: Provide full flow swing-type discharge check valve.

2.2 Sump Basins and Pits

A. Sump Basin:

1. Manufacturers:
   a. Topp Industries, Inc: www.toppindustries.com/#sle.
   b. Zoeller Company: www.zoeller.com/#sle.
2. Below Ground Pipe Inlet: Molded or predrilled with seal.
3. Molded-Finish Requirements: Hard bottom, watertight, gas-tight and radon-tight molding.
4. Maximum Effluent Temperature: Match or exceed maximum pump service temperature.
5. Basin Cover:
   a. Material: One-piece flat lid made of 1/4-inch thick steel with sealing gasket.

2.3 Electrical Work

A. Provide electrical motor driven equipment specified complete with motors, motor starters, controls, and wiring.

B. Electrical characteristics to be as specified or indicated.

C. Furnish motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified.

D. Supply manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices not shown.

PART 3 EXECUTION

3.1 Installation

A. Install products with related fittings and accessories according to manufacturer instructions.

B. Observe and provide incidentals required to complete installation in compliance with ICC (IPC).

C. Pumps:

1. Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and balancing valve on discharge.
2. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
3. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
4. Provide electrical interlocking from cooling condensate pump safety switch to associated HVAC unit(s) furnished under other Sections.

3.2 Field Quality Control

A. Operational Tests: Conduct operating tests to demonstrate satisfactory, functional, and operating efficiency.

3.3 Protection

A. Protect installed products from damage from subsequent construction operations.

END OF SECTION

SECTION 22 30 00 - PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Water heaters
B. Domestic Water Expansion tanks.
C. Water softeners.
D. In-line circulator pumps.

1.2 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2025, with Errata .

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
   2. Provide electrical characteristics and connection requirements.
   3. Indicate heat exchanger dimensions, size of tappings, and performance data.
   4. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.
C. Closeout Documents:
   1. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
   2. Project Record Documents: Record actual locations of components.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
B. Certifications:
   1. Water Heaters: NSF approved.
   2. Pressure Vessels for Heat Exchangers: ASME labeled to ASME BPVC-VIII-1.
   3. Water Tanks (Over 119 Gallons): ASME labeled to ASME BPVC-VIII-1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

PART 2 PRODUCTS

2.1 **HOUSEKEEPING PAD FOR MACHINERY (BY MECHANICAL)**

A. Housekeeping Pad Sub-bases shall be provided for all machinery such as water heaters and pumps. Each electric motor shall be mounted on the same sub-base as the driven machine.
B. Sub-bases shall generally consist of pads constructed of 2500 psi concrete with all exposed surfaces finished with cement mortar, troweled smooth. Machines other than those supported on isolation units shall be secured to concrete sub-bases with anchor bolts of ample size. All machines having bed plates and flexibly and solidly connected motors shall be grouted under the full area of the bed plates with a non-shrinking, premixed grout. After grout has set, all wedges, shims and jack bolts shall be removed and spaces filled with grout.

2.2 SUPPORTING STEEL

A. Provide structural steel framework for supporting plumbing equipment as required.

B. All steel work shall be in conformance with the requirements of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings. Material shall conform to ASTM A36.

2.3 WATER HEATERS

A. Manufacturers:

1. A.O. Smith Water Products Co: www.hotwater.com.
2. Bradford White Corporation: www.bradfordwhite.com/#sle.
3. Rheem Manufacturing Company: www.rheem.com.
4. PVI Industries: www.pvi.com
5. Lochinvar: www.lochinvar.com

B. **GAS FIRED WATER HEATER**

1. Water heater shall be as scheduled on the Drawings. Tank shall be glass lined. Heater shall be insulated with not less than 2" of insulation and cased with sheet metal casing finished in baked enamel.
2. Water heaters suitable for sealed combustion direct venting using Schedule 40 PVC air intake and exhaust pipe. Water heaters shall be approved for 0" clearances to combustibles.
3. The water heater shall be factory assembled and tested. The control shall be an integrated solid state temperature and ignition control device with integral diagnostics, LED fault display capability and a digital display of temperature settings.

2.4 DOMESTIC WATER EXPANSION TANKS

A. Manufacturers:

1. Amtrol Inc: www.amtrol.com.
2. Bell & Gossett, a xylem brand: www.bellgossett.com.
3. Taco, Inc: www.taco-hvac.com.

B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM antimicrobial diaphragm sealed into tank, and steel legs or saddles.

C. Accessories: Pressure gauge and air-charging fitting, tank drain; factory pre-charge to 40 psig with dry nitrogen. Any field modifications of the tank pressure shall be performed by the mechanical contractor to match scheduled pressure. Any additions of air to the tank shall be provided with dry nitrogen and provide label with final fill pressure on tank.

D. See schedule for size.

2.5 WATER SOFTENERS

A. Salt-Based Ion-Exchange Water Softener:

1. Manufacturers:
   a. Culligan International Company
   b. US Water Systems, Inc
   c. Water Control Corp
2. Type: Separate ion exchange and feed tanks.
3. Tank Materials: Epoxy lined steel ion exchange with one-piece resin for feed.
4. Solenoid Valves: Brass or other process-resistant suitable material.
5. Multifunctional Controller:
   a. Allows metered, timed cycle, or continuous duty usage.
   b. Full control of both softening and backwashing processes.

c. Includes setting to enable automated system water bypass.

d. Stores maximum and minimum usage when in continuous duty.

e. Displays setting, usage, and flow, date, time, and other related specifics.

f. Provides status and historical usage data including ability to filter specifics.

2.6 **IN-LINE CIRCULATOR PUMPS**

A. Manufacturers:
1. Armstrong Fluid Technology: www.armstrongfluidtechnology.com.
2. Bell & Gossett, a xylem brand: www.bellgossett.com.
3. Taco Comfort Solutions: taco.com
4. Grundfos

B. Casing: Bronze, rated for 125 psig working pressure, with stainless steel rotor assembly.

C. Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.

D. Seal: Carbon rotating against a stationary ceramic seat.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions required for applicable certifications.

B. Electrical Work: Provide automatic control and protective devices with associated wiring to interconnect related interfaced devices required for specified operation.

C. Coordinate system, equipment, and piping work with applicable electrical, fuel, gas, vent, drain, and waste support interconnections as included or provided by other trades.

D. Where water heaters or storage tanks are installed above a ceiling, above grade level, or above attic spaces, drain pan (minimum 1-1/2-inches tall) shall be installed below the water heater with minimum 3/4-inch drain. Drain line shall discharge to nearest floor drain.

E. Pipe cooled condensate produced by the combustion process from the water heater condensate connection and/or flue stack with suitable piping material to neutralizer prior to discharging into nearest floor drain.

F. Pumps:
1. Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and balancing valve on discharge.
2. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
3. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
4. Align and verify alignment of base mounted pumps prior to start-up
5. Provide electrical interlocking from cooling condensate pump safety switch to associated HVAC unit(s) furnished under other Sections.

3.2 FIELD QUALITY CONTROL

A. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface.

END OF SECTION

SECTION 22 40 00 - PLUMBING FIXTURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Flush valve water closets.
B. Wall hung urinals.
C. Lavatories.
D. Sinks.
E. Showers.
F. Eye wash fountains.
G. Electric water coolers.
H. Bottle fillers.
I. Mop sinks.
J. Utility sinks.

1.2 REFERENCE STANDARDS

A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
B. ASHRAE Std 18 - Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration; 2008 (Reaffirmed 2013).
C. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use; 1997 (Reaffirmed 2017).
D. ASME A112.18.1 - Plumbing Supply Fittings; 2024.
E. ASME A112.19.3 - Stainless Steel Plumbing Fixtures; 2022.
F. ASME A112.19.5 - Flush Valves and Spuds for Water Closets, Urinals, and Tanks; 2022.
G. ASSE 1014 - Performance Requirements for Backflow Prevention Devices for Hand-Held Showers; 2020.
H. ASSE 1070 - Performance Requirements for Water Temperature Limiting Devices; 2020.
I. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
J. NSF 61 - Drinking Water System Components - Health Effects; 2017.
K. NSF 372 - Drinking Water System Components - Lead Content; 2016.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
    1. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
C. Closeout Documents:
    1. Manufacturer's Instructions: Indicate installation methods and procedures.
    2. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
    3. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.5 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept fixtures on-site in factory packaging. Inspect for damage.

B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.7 WARRANTY

A. Provide five year manufacturer warranty for electric water cooler.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

B. This Contractor shall submit a portfolio showing fixtures and trimmings to the Architect for his approval.

2.2 **FIXTURE SUPPORT AND FASTENINGS**

A. All fixtures shall be securely anchored independent of finished wall.

B. Fastening to masonry walls shall be by brass bolts or machine screws in lead sleeve type anchorage units, or 1/4 inch brass expansion bolts of sufficient length to extend at least 3 inches into solid masonry.

C. Fastening to wood partitions shall be by the use of round head brass wood screws. Wood screws shall go into solid wood, such as wood inserts, floor joists, studs, or 2" x 6" set between studs.

D. Fixture fastening with steel stud partitions shall be done by bolting or welding a 3/8" x 6" wide steel plate to studs and extending the plate one stud beyond the first and last fixture mounting points or provide an equivalent rigid mounting frame in wall. Fixture carriers shall be provided where noted.

E. All water supply pipe stubs through walls to shower heads and to flush valves shall be securely anchored within the wall or plumbing space.

2.3 **ACCESSORIES**

A. Carriers:

1. See Fixtures

B. Stops

1. Manufacturers:
   a. Brass Craft
   b. McGuire

2. Faucet, stop valves, traps, etc., shall be heavy cast brass. Water lines to all individual fixtures shall be equipped with high grade chromium plated brass compression stop valves. Each individual fixture shall be provided with valves on the supply line.
   a. Stop valves shall be similar to Brass Craft KTCR19X C, 1/4 turn ball valve, chrome plated, with Tee handle.
   b. Stop valves with dual outlets for coffee makers, dishwashers, etc., shall be similar to Brass Craft CR1901LR1, Multi turn compression valves.

C. Undercounter Dishwashers shall be connected via approved air gap fitting.

2.4 MANUFACTURERS

A. China Fixtures
   1. American Standard, Kohler, Sloan, Zurn Commercial or approved equal.
B. Fixture Carriers
   1. Josam, Wade, Smith, Zurn, Watts or approved equal.
C. Flush Valves:
   1. Sloan, Zurn, Toto, Hydrotek (8200 Model Only) or approved equal.
D. Lavatory Trim:
   1. T & S Brass, Chicago Faucet, Zurn Commercial, Hydrotek, or approved equal.
E. Sink Trim:
   1. T & S Brass, Chicago Faucet, Zurn Commercial, or approved equal.
F. Seats:
   1. Bemis, Beneke, Church, Toto or approved equal.
G. Sinks:
   1. Elkay, Just, or approved equal.
H. Electric Water Coolers:
   1. Halsey Taylor, Elkay, Murdock or approved equal.
I. Bottle Fillers:
   1. Elkay or approved equal.
J. EW:
   1. Haws, Bradley, Stingray, Speakman, or approved equal.
K. Shower Valve:
   1. Leonard, Symmons, Zurn Temp-Gard, Chicago, Moen Commercial, or approved equal.
L. Mop Basins and Utility Sinks:
   1. Fiat, Swan, Zurn Jonespec, Mustee, Acorn, or approved equal.
M. Washer Trim:
   1. Oatey or approved equal.
N. Thermostatic Mixing Valves:
   1. Leonard, Lawler, Caleffi, Watts Regulator, Powers, or approved equal.
O. Trap Wraps:
   1. Brocar, Truebro, Plumberex, Lav-Guard, Proflo or an approved equal.

2.5 FIXTURES

A. NSF International certified sinks shall be used in all food prep areas.
B. L-1, Lavatory:
   1. Lavatory: Kohler Ladena, undermount, Vitreous china, less overflow.
   2. Trim: Sloan Optima EAF-150-ISM, battery operated, 0.5 gpm, aerator, perforated strainer, 1-1/4" brass tailpiece.
   3. Thermostatic Mixing Valve: Lawler TMM-1070-LPM, Lead Free, ASSE 1070 Certified, bronze body point of use mixing valve with 3/8” inlet and outlet compression connections, inlet check valves with stainless steel screen, and mounting bracket.
   4. Supplies: 3/8" angle supplies flexible tube riser, brass stops, chromed finish.
   5. Trap: 1-1/4" adjustable cast brass "P" trap.
   6. Trap Guard: Truebro Lav Guard 2, P-trap and wall supplies insulation kit.
C. WC-1, Water Closet:
   1. Closet: Kohler Kingston K-84325, Wall hung, Flush valve, vitreous china, siphon jet, elongated bowl, fully glazed trapway, 1-1/2" top spud, bolt caps, 1.6 or 1.28 gallon flush.
   2. Flush Valve: Sloan Royal 111 SMO-1.6, battery operated sensor flush valve, 1.6 gallons per flush..
   3. Seat: Bemis 1955SSCT white solid plastic, check hinge, self-sustaining, stainless steel hinge posts, open front, less cover.

4. Carrier: Josam, Wade, Zurn, or Smith. Note: For applications with wide chase or where the wall thickness exceeds 8” provide manufacturer’s bolt and nipple support.
5. Mounting: Refer to Architectural wall section for mounting height.

D. U-1, Urinal:

1. Urinal: Kohler Freshman K-4989-T, Wall hung, flush valve, vitreous china, siphon jet, 3/4" top spud, integral flushing rim, universal carrier.
2. Flush Valve: Sloan Royal 186 SMO-0.5, battery operated sensor flush valve, 0.5 gallon flush.
3. Carrier: Josam, Wade, Zurn, Watts or Smith.
4. Mounting: Refer to Architectural wall section for mounting height.

E. SH-1, Shower:

1. Provide floor drain in tiled floor drain. Refer to section 22 1006 - Plumbing Piping Specialties.
2. Trim: Moen Commercial T9375, single lever control, pressure balancing anti-scald valve with ¼ turn stops and 2.5 gpm shower head.
3. Mounting: Refer to Architectural elevation.

F. SH-2, Shower:

1. Provide floor drain in tiled floor drain. Refer to section 22 1006 - Plumbing Piping Specialties.
2. Trim: Moen Commercial T9375, single lever control, pressure balancing anti-scald valve with ¼ turn stops and 2.5 gpm shower head. Provide Moen 3360 diverter valve and second 2.5 gpm shower head for ADA shower operation.
3. Mounting: Refer to Architectural elevation.

G. S-1, Sink:

1. Sink: Elkay LRAD1919, Countertop, single compartment, type 304, 18-8 stainless steel, 18 gauge, self-rimming, back ledge.
2. Trim: Chicago Faucet 895-317E73-RGD2AB gooseneck spout, wristblade handles, 1.0 GPM non-aerating outlet, LK-35 stainless steel basket strainer.
3. Trap: Chrome plated cast brass "P" trap.
4. Supplies: 3/8" angle supplies with flexible tube riser, brass stops, chromed finish.
5. Size: 19-1/2" x 19" with 16" x 13-1/2" x 6" bowl.
6. Trap Guard: Truebro Lav Guard Model 102 E-Z, P-trap and wall supplies insulation kit.

H. S-2, Sink:

1. Sink: Elkay LRAD3122, Countertop, single compartment, type 304, 18-8 stainless steel, 18 gauge, self-rimming, back ledge.
2. Trim: Chicago Faucet 895-317E73-RGD2AB gooseneck spout, wristblade handles, 1.0 GPM non-aerating outlet, LK-35 stainless steel basket strainer.
3. Trap: Chrome plated cast brass "P" trap.
4. Supplies: 3/8" angle supplies with flexible tube riser, brass stops, chromed finish.
5. Size: 31" x 22" with 28" x 16" x 6" bowl.
6. Trap Guard: Truebro Lav Guard Model 102 E-Z, P-trap and wall supplies insulation kit.

I. S-3, Sink:

1. Sink: Elkay LRAD3122, Countertop, single compartment, type 304, 18-8 stainless steel, 18 gauge, self-rimming, back ledge.
2. Trim: Chicago Faucet 895-317E73-RGD2AB gooseneck spout, wristblade handles, 1.0 GPM non-aerating outlet, LK-35 stainless steel basket strainer.
3. Trap: Chrome plated cast brass "P" trap.
4. Provide with under-sink plaster trap.
5. Supplies: 3/8" angle supplies with flexible tube riser, brass stops, chromed finish.
6. Size: 31" x 22" with 28" x 16" x 6" bowl.
7. Trap Guard: Truebro Lav Guard Model 102 E-Z, P-trap and wall supplies insulation kit.

J. S-4, Sink:

1. Sink: Elkay LR3122, Countertop, single compartment, type 304, 18-8 stainless steel, 18 gauge, self-rimming, back ledge.
2. Trim: Chicago Faucet 895-317E73-RGD2AB gooseneck spout, wristblade handles, 1.0 GPM non-aerating outlet, LK-35 stainless steel basket strainer.
3. Trap: Chrome plated cast brass "P" trap.

4. Supplies: 3/8" angle supplies with flexible tube riser, brass stops, chromed finish.
5. Size: 31" x 22" with 28" x 16" x 7-5/8" bowl.
6. Trap Guard: Truebro Lav Guard Model 102 E-Z, P-trap and wall supplies insulation kit.

K. S-5, Sink:

1. Sink: Elkay LR3122, Countertop, single compartment, type 304, 18-8 stainless steel, 18 gauge, self-rimming, back ledge.
2. Trim: Chicago Faucet 895-317E73-RGD2AB gooseneck spout, wristblade handles, 1.0 GPM non-aerating outlet, LK-35 stainless steel basket strainer.
3. Trap: Chrome plated cast brass "P" trap.
4. Provide with under-sink plaster trap.
5. Supplies: 3/8" angle supplies with flexible tube riser, brass stops, chromed finish.
6. Size: 31" x 22" with 28" x 16" x 7-5/8" bowl.
7. Trap Guard: Truebro Lav Guard Model 102 E-Z, P-trap and wall supplies insulation kit.

L. S-6, Sink:

1. Sink: Elkay LRAD3319, Countertop, double compartment, type 304, 18-8 stainless steel, 18 gauge, self-rimming, back ledge.
2. Trim: Chicago Faucet 434-ABCP, deck-mounted high arc kitchen faucet with pull-down spout, single hole mount, 1.5 GPM dual-pattern outlet.
3. Trap: Chrome plated cast brass "P" trap.
4. Supplies: 3/8" angle supplies with flexible tube riser, brass stops, chromed finish.
5. Size: 33" x 19-1/2" with two 14" x 14" x 6" bowls.
6. Trap Guard: Truebro Lav Guard Model 102 E-Z, P-trap and wall supplies insulation kit.

M. US-1, Utility Sink:

1. Sink: Mustee Model 18F, floor mounted, single compartment molded stone, chrome plated strainer(s) with plug.
2. Trim: Chicago Faucet #895-L5VBXKCP ceramic disk cartridge, hose end swing spout with vacuum breaker.
3. Trap: Chrome plated cast brass "P" trap.

N. EWC-1, Electric Water Cooler with Bottle Filler

1. Elkay # EZSTL8WSLK, dual height, wall hung water cooler and bottle filling station, touch controls front and side,stainless steel top and cabinet. Bottle filler shall be sensor activated.
2. Cooler shall have the capacity to cool 8 GPH to 50°F with inlet water at 80°F and 90°F room temperature. Compressor shall be 1/6 HP, 120 volt. Tank shall be lead-free. Provide Flexi-Guard, stainless steel Safety Bubbler.

O. BF-1, Bottle Filler

1. Elkay # LZWSM8K, in-wall bottle filling station, sensor activated, stainless steel.
2. Cooler shall have the capacity to cool 8 GPH to 50°F with inlet water at 80°F and 90°F room temperature. Compressor shall be 1/6 HP, 120 volt. Tank shall be lead-free. Provide Flexi-Guard, stainless steel Safety Bubbler.

P. EW-1, Emergency Eye Wash

1. Speakman SE-490 stainless steel receptor with spray head. Push action stay open ball valve, stainless steel push flag and wall brace, universal emergency eye-wash sign.
2. Furnish and install a Leonard Model EXL-300-LF, thermostatic mixing valve for each eye wash. Controller shall be rough bronze finished thermostatic mixing valve with thermometer and inlet check valves. Discharge temperature shall be set at 85°F. All exposed mixing valves shall be chrome plated. Provide stops and check valves for installation. Provide stainless steel wall box with lockable door suitable for 4-inch wall. Mount at eye level adjacent to eyewash unit.

Q. MB-1, Mop Basin:

1. Basin: Fiat Model SB2424 Berkeley Terrazzo mop basin, 3" stainless steel drain body with dome strainer.
2. Trim: Chicago Faucet #897-CP ceramic disk cartridge, service sink faucet with vacuum breaker, 3/4" hose thread spout, adjustable wall brace, pail hook. Furnish 31” garden hose.
3. Provide horizontal swing, Y-pattern check valves similar to Nibco #T/S-413 to be installed in hot and cold supply lines.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
B. Verify that electric power is available and of the correct characteristics.
C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.2 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.3 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.
B. Provide chrome plated rigid or flexible supplies to fixtures with handle stops, reducers, and escutcheons.
C. Install components level and plumb.
D. Install and secure fixtures in place with wall carriers and bolts.
E. Solidly attach water closets to floor with lag screws. Lead flashing is not intended to hold fixture in place.
F. Where fixtures come in contact with floor or wall, joint shall be sealed with silicone caulking of color to match fixture.
G. Provide stainless steel wall escutcheon on waste pipe through the wall for lavatories and sinks.
H. For all flush valves installed in ADA installations, coordinate space for service of flush valve with grab bars.
I. For connection to residential dishwasher, provide stainless steel braided hose from stop valve to dishwasher connection.

3.4 INTERFACE WITH WORK OF OTHER SECTIONS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.
B. Kitchen Equipment:
    1. Equipment furnished by the Kitchen Equipment Supplier/Contractor shall have rough-ins and accessories, provided by this contractor. Final mounting and connections including indirect connections shall also be provided by this contractor.
    2. Coordinate with them for a complete system including shut-offs, risers, tail piece, traps, etc.
    3. Connections may included but not be limited to cold water, hot water, waste, vent, and gas.
    4. Kitchen equipment hand sinks shall be provided with ASSE 1070 thermostatic mixing valve by this contractor unless otherwise coordinated with the Kitchen Equipment Supplier/Contractor.
C. Lab Equipment
    1. Equipment furnished by the Lab Equipment Supplier/Contractor shall have rough-ins and accessories, provided by this contractor. Final mounting and connections including indirect connections shall also be provided by this contractor.
    2. Coordinate with the Lab Equipment Supplier/Contractor for a complete system including shut-offs, risers, tail piece, traps, etc.
    3. Connections may included but not be limited to cold water, hot water, waste, vent, and gas.

3.5 ADJUSTING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

A. Clean plumbing fixtures and equipment.

3.7 PROTECTION

A. Protect installed products from damage due to subsequent construction operations.
B. Do not permit use of fixtures by construction personnel.
C. Repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 23 00 60 - MECHANICAL DEMOLITION

PART 1 GENERAL

1.1 DESCRIPTION

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

B. This section specifies the demolition and removal of all HVAC equipment and distribution conduits including but not limited to ductwork, piping, controls, insulation, and accessories in existing building.

C. Unless otherwise noted in the Documents, all salvage items removed in connection with this Contract are to become the property of the Contractor, however the Owner shall have the first right of refusal on all equipment removed.

1.2 SUBMITTALS

A. Proposed Dust Control and Noise Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate.

B. Schedule of selective demolition activities:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Interruption of building utility services.
3. Coordination for shutoff, capping and continuation of services.
4. Coordination of Owner's continued occupancy of portions of existing building and of Owner's occupancy of completed work.

C. Pre-demolition photographs or videotape showing existing pre-demolition conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by selective demolition operations. Submit before demolition work begins.

1.3 PROJECT CONDITIONS

A. Owner will occupy portions of the building immediately adjacent to selective demolition area. Conduct demolition so Owner's operation will not be disturbed. Provide not less than 48-hour notice to Owner of activities that will affect the Owner's operations.

B. Maintain existing services to Owner occupied areas during demolition if possible or coordinate interruption of services prior to demolition.

C. Owner assumes no responsibility for condition of area to be selectively demolished.

D. Hazardous Materials:

1. It is not expected that hazardous materials will be encountered in the Work.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify field measurements and existing ductwork and piping arrangements are as shown on Drawings.

B. Verify that abandoned equipment serves only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents. The demolition Drawings are diagrammatic and show the general scope of demolition work and do not show all the construction detail of the original record drawings. Report discrepancies to the Project Engineer before disturbing existing installation.

D. The Contractor shall visit the existing building and grounds and review the existing building record drawings for details of existing installation to familiarize themself with existing conditions prior to submitting bid. No allowance will be made subsequently, in this connection, on behalf of the Contractor for any error or negligence on his part.

E. Beginning of demolition means the Contractor accepts existing conditions.

3.2 **PREPARATION**

A. Disconnect mechanical systems in areas scheduled for removal. Notify Project Engineer and Owner of areas to be affected by mechanical demolition work prior to commencing.

3.3 **SELECTIVE DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK**

A. Demolish and remove from site and extend existing mechanical work under provisions of this Division and as indicated on the Drawings unless otherwise noted.

B. Salvage items noted to remain the property of the Owner shall be delivered to a location to be designated by the Owner. Contractor shall remove from construction areas all trash or debris as it accumulates and dispose of it off site at no additional cost to the Owner. All construction areas shall be kept clean, safe, and orderly at all times. At the completion and acceptance for work, Contractor shall remove from the site all debris and surplus materials resulting from this work and dispose of them off site at no additional cost to the Owner.

C. Do not use cutting torches until work area is clear of flammable materials. At concealed spaces verify condition and contents of hidden space before starting flame cutting operations. Maintain Fire Watch and portable fire-suppression devices during flame-cutting operations. Maintain and evaluate ventilation during flame-cutting operations.

D. Maintain ventilation for dust control during selective demolition process. Verify Owner requirements for dust control and conform to their standards for all demolition activities.

E. Remove, relocate, and extend existing installations to accommodate new construction as required for proper installation and system operation.

F. Remove all accessories above grade. When removing equipment or terminal devices all associated pipe, duct, ATC devices, wiring, etc. shall be removed and capped as required. Cut piping, duct, tubing, etc. behind walls, above ceilings and below floors, and patch surfaces to match existing conditions. Finishes will be by others unless otherwise noted in documents.

G. Neatly cut openings and holes plumb, square and true to dimension required. Use cutting methods least likely to damage construction to remain or adjoining construction. Cut and drill from exposed surfaces into concealed surfaces to avoid marring or spalling of finished surfaces. Temporarily cover openings to remain.

H. Patch all openings created by removal of mechanical equipment, ATC devices, ducts, pipes, etc. unless noted as being patched by others. Openings to be patched to match existing with similar materials and finish unless otherwise noted.

I. Seal all existing roof penetrations, which will not be reused. Roof patching shall be by project roofing contractor, or an Owner approved roofing contractor.

J. Remove, relocate, or provide brackets, hangers, and other accessories as required.

K. Repair adjacent construction and finishes damaged during demolition and extension work.

L. Maintain access to existing mechanical installations, which remain active.

3.4 SALVAGE

A. All items removed from existing building shall be salvaged in a workmanlike manner.

B. The handling, storage, and disposition of salvage materials shall be as directed by the Architect. Generally, all salvage material shall remain the property of the Owner. Materials and equipment not wanted by Owner shall be removed from the job site and become the property of the contractor.

3.5 CLEAN AND REPAIR

A. Clean and repair existing materials and equipment, which remain or are to be returned to the Owner.

B. All building surfaces damaged and openings left by new Work or the removal or relocation of mechanical equipment, piping, etc., shall be repaired to original condition and painted by the Contractor.

END OF SECTION

SECTION 23 01 00 - MECHANICAL GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 APPLICABILITY

A. This section applies to and forms a part of each of the sections of Division 23. This section, and each of the sections to which it applies, is subject to the requirements of the Instructions to Bidders, General Conditions, and Special Conditions of these complete specifications.

B. The work covered by this Division of the Specifications consists of furnishing all labor, supervision, equipment, materials, all incidentals, related items, and appurtenances, and performing all operations necessary to complete the installation of work in strict accordance with these specifications and drawings.

C. All work shall be finished, tested and ready for operation.

1.2 DEFINITIONS

A. Words "Material" or "Furnish" where written in Division 23 specifications and drawings shall mean any and all apparatus, equipment, devices, fixtures, components, products, assemblies, items, parts, things, and any other pieces specified or shown or required.

B. Words "Labor" or "Install" where written in Division 23 specifications and drawings shall mean any and all physical effort, manpower, time, expertise, tools, equipment and services to carefully assemble, install and affix all material in a proper, complete and acceptable manner.

C. Word "Provide" where written in Division 23 specifications and drawings shall mean "Mechanical Contractor shall furnish all labor and material and completely and properly install such material and leave same in acceptable condition and intended acceptable working order".

1.3 DISCREPANCIES OR OMISSIONS FROM DRAWINGS OR DOCUMENTS

A. Notify the Engineer of any discrepancies in, or omissions from the drawings or documents. Neither the Owner nor the Architect will be responsible for any oral instructions or modifications of the specifications or drawings. Written interpretations will be made only by Addenda.

B. If discrepancies are not reported, the contractor shall bid the greater quantity or better quality (highest dollar value), and appropriate adjustment will be made after contract award.

C. Discrepancies discovered during construction shall immediately be called to the attention of the Architect/Engineer for clarification.

D. All minor items necessary for the completion and successful operation of the system, whether or not herein definitely specified or indicated on the drawings, shall be furnished and installed.

E. Omission of/or express reference to any material necessary for/or reasonably incidental to complete installation shall not release Contractor from providing such material. Where material is shown on drawings but is not specified or is specified but not shown, such material shall be considered both shown and specified.

F. Any work not clear to Contractor shall be referred to Engineer for clarification before bid is submitted. If no question is raised prior to opening of bid, Contractor shall be required to provide work in question as directed by Engineer, whose decision is final, without additional charges.

G. By virtue of submitting a bid, Contractor agrees that they are skilled and experienced in use of and in interpretation of drawings and specifications. Contractor further agrees that they have carefully reviewed all drawings, all specifications, and all addenda, which constitute bid documents for this contract, and finds them free of ambiguities and good and sufficient for bidding and construction purposes.

1.4 DRAWINGS

A. The drawings indicate the extent and general layout of the mechanical systems intended for the building. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, connections,

and accessories which may be required. Furnish offsets, fittings, valves, and accessories as may be required, to produce a complete and operating installation of type shown and specified.

B. All piping and ductwork shall be routed so as not to obstruct access to other equipment (i.e. VAV box controls, electrical devices, fire alarm devices, etc.). Routing indicated on drawings is representative of intended location but shall be field verified. It shall be this contractor's responsibility to coordinate with other trades for accessibility.

C. Any work or system on the roof not explicitly indicated on the roof plan shall be approved by the engineer prior to installing.

D. In general, the mechanical equipment drawings are drawn to scale as noted. Obtain dimensions and locations of partitions, walls, etc., from the Architectural drawings wherever possible and do not scale the mechanical drawings. Consult the Architectural drawings for details of construction, location of suspended ceilings, ceiling heights, and other pertinent information. Architect's drawings shall not take precedence over field measurements.

E. All drawings and specifications shall be considered in bidding. The drawings and specifications are complimentary, and what is called for in either of these shall be as binding as though called for by both. Should any conflict arise between drawings and specifications, such conflict shall be brought to the attention of the Architect.

1.5 SITE INSPECTION

A. Before submitting a proposal for the work contemplated in these specifications and accompanying drawings, each bidder shall examine the site and familiarize themselves with all the existing conditions and limitations, including the extent of demolition, cutting, and patching to be done by the Contractor for Mechanical Work. No extras will be allowed because of the Contractor's misunderstanding as to the amount of work involved, or his lack of knowledge of any condition in connection with the work.

1.6 **PRIOR APPROVAL REQUESTS**

A. Where the Bid Documents stipulate a particular Product, substitutions will be considered by the Engineer up to 10 days before receipt of bids.

B. The submission shall provide complete information, test, etc. relating to quality, performance, suitability, to determine acceptability of such products.

C. When a request to substitute a Product is made, the Engineer may approve the substitution and will issue an Addendum to known bidders.

D. Provide Products as specified unless substitutions are submitted in this manner and subsequently accepted.

E. The cost of any changes of other trades as a result of use of the substitution material or equipment must be borne by the Contractor submitting such material or equipment.

1.7 **REVIEW OF MECHANICAL MATERIALS AND EQUIPMENT**

A. Within thirty (30) days after award of construction contracts, Contractor shall submit for acceptance to the Architect quantity of shop drawings specified for the equipment indicated in these specifications. The shop drawings shall include the equipment manufacturer's name and address, catalog designation or model number, rough-in data & dimensions, performance curves and rated capacities & operational characteristics.

B. The Contractor shall thoroughly review each item for compliance with these Specifications making any necessary corrections prior to submittal. Each shop drawing set shall be stamped, signed, and dated indicating Contractor review and submitted electronically via PDF file format. The PDF file name shall include the relevant specification section number for reference. If the Contractor fails to properly review shop drawings, the Contractor shall reimburse the Engineer for all additional reviews on a time and material basis.

C. Provide samples of materials or equipment proposed to be furnished, if requested. Samples shall become the property of the Architect/Engineer and will be returned only when accompanied by a written request to do so.

D. None of the items listed shall be purchased, delivered to the site, or installed, until the item is reviewed. No substitution will be permitted after review except where such substitution is considered by the Architect to be in the best interest of the Owner.

E. The Engineer will review all Shop Drawings submitted and will retain a copy for record file.

F. Approval Stamp: This review is to verify general conformance with the design concept of the Project and substantial compliance with the information provided in the Contract Documents. This review does not in any way relieve the Contractor or their suppliers of their responsibility to provide all materials and equipment as specified, in quantities, quality and dimensions required. Submittals will be reviewed with the following actions:

1. "No Exception Noted" indicates that the Submittal appears to conform to the design concept of the Work and that the Contractor, at their discretion, may proceed with fabrication and/or procurement and installation.
2. "Make Corrections Noted" indicates that the Submittal, after noted corrections are made, appears to conform to the design concept of the Work and that the Contractor, at their discretion, may proceed with fabrication and/or procurement and installation, if the corrections are accepted by the Contractor without any increase in Contract Sum or Time.
3. "Revised and Resubmit" indicates that the noted revisions are such that a corrected copy of the Submittal is required for review to confirm that the noted revisions have been understood and made. The Contractor, at their discretion, may proceed with fabrication and/or procurement and installation after submitting a corrected copy and verifying with the reviewer that the corrected copy is acceptable, if the corrections are accepted by the Contractor without an increase in the Contract Sum or Time.
4. "Rejected" indicates that the Submittal does not appear to conform to the specifications, a resubmission is required, and fabrication or procurement is not authorized.

G. If the Engineer rejects (Revised and Resubmit or Rejected) the same section two times the engineer shall be compensated for additional reviews. Any subsequent submittal will require the inclusion of a check made out to the engineer in the amount of $500.00. Contractor is responsible for all delays caused by the resubmittal process.

H. Should the contractor fail to comply with any of the requirements of the preceding sub-paragraphs; then the right is reserved by the Architect to select any or all items in the material schedule, with that selection to be final and binding upon the contractor. The materials selected or reviewed, as the case may be, by the Architect, shall be used in the work at no additional cost to the Owner.

I. When the contractor chooses to furnish and reviewed material or equipment that requires electrical specifications/connections (circuit breaker, conduit, wire, labor, etc.) different than shown and/or scheduled on the drawings, or specified in detail, the contractor shall be responsible for coordinating any necessary changes and shall bear the cost of such changes (including engineering costs).

1.8 PROPOSAL REQUESTS AND INSTRUCTIONS

A. For any proposal request or instruction that requires an adjustment to the Contract Sum, submit an itemized quotation for the change(s) described in the proposed modifications to the Contract Documents. Proposal shall also indicate credits, deducts, and/or offsets for material and labor originally included in contract.

1. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. Breakdown shall include amounts, lengths, quantities, types, sizes, etc. of material.
2. Indicate applicable taxes, O&P, delivery charges, equipment rental, and other incidental charges.
3. Include costs of labor and supervision directly attributable to the change.
4. All sub-contractor pricing shall include the same breakdown as described above.

1.9 warranty

A. All equipment and installation shall be provided with a 1-year warranty beginning with substantial completion.

B. Refer to individual spec sections for specific warranty information that is different than stated above.

C. Submit warranty with related forms completed in Owner's name and registered with manufacturer.

1.10 **MANUALS**

A. In addition to catalog data and shop drawings submitted for review, this contractor shall furnish Operation and Maintenance Manuals for the mechanical systems. Manuals shall be delivered to the Architect before final observation of the work.

B. Operation and Maintenance Manuals shall be furnished in PDF electronic format as well as two (2) copies bound in new hard backed 3 ring binders with the title "Operations and Maintenance Manuals" and the project title clearly printed on the front cover and side of binder .

C. Provide an index at the beginning of the manual for the sections included in the manual. Material shall be listed in specification sequence order.

D. All sections in hard copy manuals shall be referenced with plastic tabs.

E. Operation and Maintenance Manuals shall contain:

1. Approved shop drawings clearly showing the models, sizes and capacities of equipment used.
2. Manufacturer's operating, parts list, maintenance, installation, lubrication and cleaning instructions.
3. Factory startup reports, test and balance reports.
4. Valve tag list.
5. Name and address of authorized service organization and parts depot.
6. Chemical Treatment Analysis Reports for heating & cooling systems.
7. Radiographic Testing Reports of welded pipe with picture of weld & location plan showing physical location of where test was performed.
8. A description of how the components of a given HVAC system interact within the large system. For example, circulating pumps, boilers, unit heaters are part of the "heating system".
9. A description of normal operating conditions for the system and its components.
10. A description of common symptoms of a malfunctioning system and likely causes.
11. Warranty letter from the automatic temperature controls contractor indicating the warranty period for their portion of the work.
12. Signed owner instruction forms for all items specified as requiring owners' instruction.
13. The Systems manual shall have an index and be broken up by individual systems such as "heating", "shop exhaust", "kitchen ventilation and exhaust", "chilled water", "administration ventilation".
14. Include at the front of the manual a complete listing of the Architect, Engineer and contractors and sub-contractors used on the project. Listing shall include names, addresses and phone numbers for each.
15. All major pieces of equipment shall be referenced with the equipment supplier's name, address and phone number shall be provided.

F. Operations and Maintenance Manuals shall be submitted to the Engineer for approval prior to delivery to the Architect.

1.11 **INSTRUCTION OF OWNER'S EMPLOYEES**

A. Furnish, without additional expense to the Owner, the services of competent instructors, who will give full instructions in the care, adjustment, and operation of all parts of the mechanical equipment to the Owner's employees who are to have charge of the equipment.

B. An operating and maintenance manual shall be made available to the Owner's operating personnel during the instruction and left with the Owner upon completion of the instruction.

C. The number of man hours of instruction furnished for each system shall be as specified below. Hours of instruction shall be divided up into a minimum of two (2) instruction periods with 75% of time used for an initial instruction and 25% of time used for a follow up instruction, a minimum of four (4) weeks after initial instruction.

D. Instruction of Owner's Employees" form at end of this section shall be filled out and signed by Contractor and Owner's Representative and three (3) signed copies of form sent to Engineer.

E. Owner training and instructions:

1. Heat generation systems including but not limited to boilers shall not be less than four (4) man hours.
2. Refrigeration equipment including but not limited to split systems shall not be less than two (2) man hours.
3. Heat transfer systems including but not limited to circulating pumps and terminal heating and or cooling units shall not be less than four (4) man hours.
4. Ventilation systems including but not limited to make-up air units, packaged rooftop units, exhaust fans, energy recovery units, and terminal air units shall not be less than four (4) man hours.
5. Automatic temperature control systems including all components of the system shall be not less than eight (8) man hours.

1.12 INSTALLATION OF EQUIPMENT

A. All appliances and equipment shall be installed and connected in accordance with manufacturer's instructions and recommendations unless such instructions are in conflict with these specifications. Auxiliary piping, valves, electrical connections, etc., recommended by the manufacturer or required for proper operation shall be furnished and installed complete.

B. All equipment shall be installed in such a manner and location as to facilitate accessibility for maintenance and/or replacement.

C. As a part of the work of this contract, the Mechanical Contractor shall make any changes in the pulleys, belts, and dampers, and shall install additional dampers required for correct balance as recommended by air balance agency, at no additional cost to the Owner.

D. The use of permanent HVAC systems for temporary heating, cooling, ventilating, and conditioning is strictly prohibited without written authorization from the Engineer.

1.13 RECORD DRAWING

A. The contractor shall maintain one set of drawings at the job site used as a master copy. Each change order or other revision, deletion, or addition shall be clearly marked and noted by colored pencil. This copy of plans shall be furnished to the Architect upon completion of the project.

B. The contractor shall note on the record drawings the elevations and/or inverts of all mechanical services (i.e., sewer, water, etc.) where they exit the building foundation. The contractor shall also record dimensions from the building to points on all mechanical equipment installed (ie., fuel tanks, oil piping, etc.).

C. A complete set of these drawings shall be scanned at a resolution of 600dpi in color and saved in an Adobe PDF portfolio format with index to each sheet by name and burned to a non-volatile media. The electronic copy of the as-built drawings shall be transmitted to the Engineer. After review and approval by the Engineer, the as-built drawings will be turned over to the Owner.

1.14 COOPERATION WITH OTHER TRADES

A. Cooperate with other trades so as to avoid interferences. Where required to avoid interferences with other work or to increase the headroom, the Contractor shall off-set the piping and/or re-route the duct work where directed by the Engineer. Carefully check all construction details to assure the proper installation of all work under this specification. Schedule the work such that it will keep pace with the work of other crafts and cause no delay.

1.15 INSPECTION OF SITE

A. Before submitting a proposal on the work contemplated in these specifications and accompanying drawings, each bidder shall examine the site and familiarize themselves with all of the existing conditions and limitations. No extras will be allowed because of Contractor's misunderstanding as to the amount of work involved or lack of his knowledge of any condition in connection with the new construction.

1.16 **PAVEMENT, CURB AND SIDEWALK REPLACEMENT**

A. This Contractor shall be responsible for replacement of existing street pavement, curbs, and sidewalks, etc., removed or damaged by them during the course of the work, unless such pavement, curbs, sidewalks are to be constructed under the General Contract. The work shall be done in accordance with local requirements.

1.17 **SALVAGE**

A. All items removed from existing building shall be salvaged in a workmanlike manner.

B. The handling, storage, and disposition of salvage materials shall be as directed by the Architect. Generally, all salvage material shall remain the property of the Owner. Materials and equipment not wanted by Owner shall be removed from the job site and become the property of the contractor.

1.18 **CODES, ORDINANCES, REGULATIONS & STANDARDS**

A. The entire installation shall be made in accordance with all state and local laws. If, in any instance, the plans and specifications conflict with such laws, the law shall take precedence. This, however, shall not be construed as relieving the contractor from complying with any requirements of the drawings and specifications that may be in excess of the rules and not contrary to the same.

B. All work shall conform to applicable state and local codes, ordinances, regulations and/or standards.

1.19 **PERMITS AND LICENSES**

A. This contractor shall obtain and pay for all licenses and permits and shall pay for all fees and charges for the connection to outside services and use of property other than the site of the work for storage of materials or other purposes.

B. Contractor shall coordinate and request all inspections from authority having jurisdiction. The Contractor shall notify the Architect of all such coordinated inspections (date & time) and shall submit certificates of inspection and final approval of the local inspection authority.

1.20 **TESTS**

A. Test all equipment installed under these specifications and demonstrate its proper operation to the Engineer.

B. Do not test or operate equipment for any purpose, until it has been fully lubricated in accordance with the manufacturer's instructions and, if it is a centrifugal pump, until it has been connected to the piping system with sufficient water so that it will not run dry.

C. Submit to the Engineer air balance and water balance reports indicating test results as hereinafter specified under Section 230593 "TESTING, ADJUSTING AND BALANCING FOR HVAC".

D. All testing shall be completed before final inspection, and test results shall be available during the final inspection.

1.21 **GUARANTEES**

A. This contractor shall guarantee all equipment, material, and workmanship for a period of one year from date of final certificate. Any defects in mechanical equipment, workmanship or materials that appear, or cause trouble of any kind within a period of one year from date of final certificate shall be remedied, free of charge. Refer to other sections of these specifications for guarantees in excess of the requirements herein described.

1.22 **CONSTRUCTION CLOSEOUT DOCUMENTS**

A. This Contractor and their subcontractors should proceed immediately to fully complete the work as listed at the end of this Section. The Contractor responsible shall initial and date the "Contractor Completed" column after each item as it is complete and forward a copy of the fully completed punch list to the Engineers for their final approval before final punch list inspection. Reply with an NA where items don’t pertain.

PART 2 PRODUCTS

2.1 Not used

PART 3 EXECUTION

3.1 INSTRUCTION TO OWNER'S EMPLOYEES FORM

DATE _____

INSTRUCTION OF OWNER'S EMPLOYEES

This letter shall certify that the Contractor has furnished the Owner with full instructions in the care and operation of all parts of the mechanical system as specified under Section 23 0100 paragraph entitled "Instruction of Owner's Employees".

	Owner's Initial Instructions			Owner's Follow-up Instructions		
Section	**Hours**	**Date**	**Initials**	**Hours**	**Date**	**Initials**
Heat Generation						
Refrigeration						
Heat Transfer						
Ventilation						
Temperature Control						

END OF SECTION

SECTION 23 01 50 - MECHANICAL MATERIALS & METHODS

PART 1 GENERAL

1.1 APPLICABILITY

A. This section covers basic materials and methods and applies to and forms a part of each of the sections of Division 23.

B. This work shall be in accordance with this and other applicable sections and/or provisions of these specifications and with the applicable drawings.

1.2 COORDINATION OF OPENINGS

A. This contractor shall coordinate all openings required for new piping, ductwork, equipment, controls, etc. through any structural slabs, beams, or walls. Contractor shall request a copy of the precast concrete shop drawings and verify locations and sizes of all openings required.

B. All costs associated with structural field changes or redesigns of the building systems due to lack of field coordination shall be responsibility of this contractor.

1.3 MATERIALS & MANUFACTURERS

A. All materials and equipment shall be new, free of defects, installed in accordance with manufacturer's current published recommendations in a neat manner and in accordance with standard practice of the industry.

B. Certain materials and/or equipment in this specification are specified by manufacturer and catalog numbers. The design was based on the specified equipment and establishes a degree of quality, performance, physical configuration, etc. If the contractor should elect to use equipment other than the equipment used as a basis for design but listed as "acceptable" in the specifications, he shall be responsible for space requirements, configuration, performance, and changes in bases, supports, vibration isolators, structural members, openings in structure and other apparatus that may be affected by its use.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

A. Piping is to be installed as shown on the drawings as much as practical. When a pipe size is not indicated, the subcontractor shall request the pipe size from the Architect through the Mechanical Contractor.

B. Provide sufficient swing joints, expansion loops, and/or devices necessary and install so as to permit free expansion and contraction of piping without causing undue stresses. Make all changes in direction with fittings. Support piping independently at all equipment so that its weight shall not be supported by the equipment.

C. Install piping without springing or forcing and clear all windows, doors, and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted.

D. All pipes shall be reamed to full pipe diameter before joining.

E. Install vertical risers plumb and straight, horizontal lines parallel with walls and partitions. Conceal piping above ceilings and within furring and/or walls (finished construction).

F. Provide shut-off valves and unions suitably located to isolate each item of equipment, branch circuit or section of piping.

G. Provide solid head plugs on any crosses, tees, etc., located in the piping around the boilers.

H. Provide drain valves at all low points of each system to enable complete drainage. Drain shall consist of a 3/4” ball valve with hose end.

I. Provide a manual air vent consisting of 1/2" ball valve with hose end installed on a "T" at all high points of each system to enable complete venting.

J. All piping shall be adequately supported from the building structure with adjustable hangers to maintain uniform grading where required and to prevent sagging or pocketing.

K. Provide supports between piping and building structure where necessary to prevent swaying.

L. The use of wire or perforated metal to support pipe will not be permitted.

2.2 **SUPPORTING STEEL**

A. Provide structural steel framework for supporting mechanical equipment as required.

B. All steel work shall be in conformance with the requirements of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings. Material shall conform to ASTM A36.

PART 3 EXECUTION

3.1 **PROTECTION, DELIVERY AND STORAGE OF MATERIALS**

A. Make provisions for the delivery and storage of materials and make the required arrangements with other contractors for the introduction into the building of equipment too large to pass through finished openings.

B. Protect materials and equipment stored on site from weather and moisture by maintaining factory covers and/or suitable weather-proof coverings. For extended outdoor storage, motors shall be removed from equipment and stored separately.

C. The open ends of all piping and ductwork shall be covered whenever that system is not being worked on, i.e., end of the workday, completion of a section, etc. Covering shall keep dust, garbage, vermin, and other foreign objects out of the piping or ductwork when the contractor is not on the jobsite.

3.2 **CUTTING AND REPAIRING**

A. All holes and penetrations required for the installation of the mechanical equipment shall be by the mechanical contractor. This shall include all piping, ductwork, and any other penetration through the wall, floor, or roof.

B. Cutting construction shall be done only with the written permission of the Architect. Cutting shall be done carefully and damage to buildings, pipes, wiring, or equipment as a result of cutting for installation shall be repaired by skilled mechanics of the trade involved at no additional charge to the Owner. This Contractor shall be responsible for all cutting and patching unless such work has been delegated to the General Contractor.

C. All holes cut into concrete shall be cut by means of power saws or core drills. All unsightly spalls or chips shall be repaired.

D. All openings remaining around duct and pipe penetrations shall be filled, caulked, and painted to match wall. Code approved fire caulking shall be used for all rated penetrations.

3.3 **SEALING FLOOR, CEILINGS AND WALL OPENINGS**

A. Where pipes or ducts pass through walls, ceilings, floors, or partitions, (other than those through fire rated walls or chases) the opening in the construction around the pipe or duct shall not exceed ½ inch average clearance on all sides and shall be sealed to prevent the passage of sound and air. Coordinate wall openings to allow insulation thickness to pass through walls if allowed.

B. The material used to seal space between the wall and the pipe/duct shall be non-combustible caulk type, or wrap type, as conditions require. Provide sheet metal angles or flanges as may be required to contain the stopping material. Use of expanding foam will be allowed if surfaces are cleaned of an excess material and all edges are trimmed smooth. Penetrations through exterior walls shall be sealed weather tight.

C. Special attention shall be given to penetrations of mechanical room walls. Fill gaps around entire exterior area of the pipes or ducts with sound insulation (batt or mineral wool) to within ½” of the wall surface. Use silicone caulking to finish filling the opening smooth with the wall surface or provide sheet metal angles. All sealer shall meet flame spread 25 and smoke developed less than 50.

D. Where pipes or ducts pass through fire-rated walls, ceilings, floors, vertical service shafts walls, or partitions, the opening in the construction around the pipe or duct shall be fire-stopped to prevent the passage of flame and smoke. All assemblies shall be UL or ASTM listed to provide a fire rating equal to that of the construction being penetrated. For the firestop applications that exist for which no UL tested system is available through a manufacturer, an engineering judgment derived from similar UL system designs or other tests shall be submitted from the manufacturer to the local authorities having jurisdiction for their review and approval prior to installation. Individuals installing the firestopping shall be experienced and certified as required by the manufacturer whose product is being applied. Refer to firestopping specification section for more information.

E. Manufacturer's assembly drawings shall be provided in O & M Manuals for each type of penetration. Printed metal or plastic labels shall be permanently applied on the structure within 6" of the edge of the firestop system. Metal labels shall be applied with mechanical fasteners & plastic labels shall be the self-adhering type with adhesive capable of permanently bonding labels to the surfaces on which the labels are placed. The information required on the label include UL/ASTM assembly number, date of installation, fire stopping material manufacture name, Contractor's name, address & phone number & the installer's name.

F. Duct coverings shall not extend through walls or floors required to be fire-stopped or have a fire resistance rating. Insulation shall be taped or sealed to the walls to eliminate sweating at any fire and/or smoke dampers.

G. Acceptable manufacturers shall be Hilti, 3M Brand, or a prior approved product.

3.4 CLEANING AND PAINTING

A. Clear away all debris, surplus materials, etc., resulting from work or operations, leaving the job and equipment furnished under this contract in a clean condition.

B. All exposed ductwork visible behind grilles, registers or air terminals shall be painted flat black.

C. All equipment being furnished with finished paint coat shall be examined upon job completion for scratches and other surface damage. All finished surfaces where necessary shall be touched up with touch-up paint of color to match the factory finish.

D. Paint all exposed bare pipe exterior of the building. Bare pipe shall be painted one coat of No. 7769402 damp-proof red primer as manufactured by Rust-Oleum Corporation, or equal, and one coat of oil paint. Final coat shall be of a color selected by the architect.

E. Paint all exposed iron and steel work, pipe hangers, pipe stands, uninsulated tanks, supporting steel for equipment and exposed bare pipe in mechanical areas. Iron and steel work and bare pipe shall be painted one coat of No. 4769402 damp-proof red primer as manufactured by Rust-Oleum Corporation, or equal, and one coat of oil paint. Iron and steel work shall be painted black.

3.5 Asbestos free building

A. There shall be no products or building materials used as a temporary or permanent element in the construction of this building, which has in its make-up any form of asbestos. The contractors shall be responsible to monitor shop drawings and product literature to verify the make-up of materials to be used in the building and remind material suppliers that their products must be asbestos free.

B. Notify the Architect immediately of any existing materials which are suspected of containing asbestos. Do not disturb or attempt to remove any asbestos containing material. The Architect will contact the Owner and inform them of the Contractors observations. The Owner will obtain and provide the services of professionals skilled in asbestos removal.

3.6 HOUSEKEEPING PAD FOR MACHINERY (BY MECHANICAL)

A. Housekeeping Pad Sub-bases shall be provided for all machinery such as air handlers, pumps, and/or where called out on plans.

B. Housekeeping pads shall be a minimum of 4-inches thick and shall follow all manufacturer's instructions and requirements for support.

3.7 **SALVAGE**

A. All items removed from existing building shall be salvaged in a workmanlike manner.

B. The handling, storage, and disposition of salvage materials shall be as directed by the Architect. Generally, all salvage material shall remain the property of the Owner. Materials and equipment not wanted by Owner shall be removed from the job site and become the property of the contractor.

END OF SECTION

SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015 (Reaffirmed 2020).
B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2017.
C. NEMA MG 00001 - Motors and Generators; 2024.
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Closeout Documents:
   1. 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. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Allis Chalmers
B. Baldor Electric Company/ABB Group: www.baldor.com.
C. Emerson
D. General Electric
E. Marathon
F. Regal-Beloit Corporation (Century): www.centuryelectricmotor.com.
G. Reliance

H. Westinghouse

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service:
   1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
   2. Motors Larger than 1/2 Horsepower:480/3P , 60 Hz

B. Construction:
   1. Open drip-proof type except where specifically noted otherwise.
   2. Design for continuous operation in 104 degrees F environment.
   3. Design for temperature rise in accordance with NEMA MG 00001 limits for insulation class, service factor, and motor enclosure type.
   4. All motor shall be premium efficiency type.

C. 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.

D. 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 threaded conduit connection in end frame.

2.3 APPLICATIONS

A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.

B. Motors located in explosion proof environments and dust collection systems: Totally enclosed type explosion proof.

C. Motors located in exterior locations, air cooled condensers, humidifiers, direct drive axial fans, and roll filters: Totally enclosed type.

D. Motors located in outdoors, in wet air streams downstream of sprayed coil dehumidifiers, in draw through cooling towers, and in humidifiers: Totally enclosed weatherproof epoxy-treated type.

E. Motors driven by Variable Frequency Drives shall in be listed for the application.

2.4 SHAFT GROUNDING

A. All motors over 1 HP on variable frequency drives shall be equipped with shaft grounding system to discharge shaft voltage potential to ground. Motors on variable frequency drives shall be bonded from the motor foot to system ground with high frequency grounding strap consisting on tinned, copper strap with terminations to accommodate the motor foot and system ground.

2.5 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.6 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.7 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Design, Construction, Testing, and Performance: Comply with NEMA MG 00001 for Design B motors.

D. Insulation System: NEMA Class B or better.

E. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

F. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

G. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

H. Sound Power Levels: To NEMA MG 00001.

I. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

J. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

K. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

2.8 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. . Electronically Commutated Motor

1. Motor to be a DC electronic commutation type motor (ECM) specifically designed for application.
2. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
3. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
4. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION

SECTION 23 05 19 - METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Flow meters.
B. Pressure gauges and pressure gauge taps.
C. Thermometers and thermometer wells.

1.2 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.
B. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Provide list that indicates use, operating range, total range and location for manufactured components.

PART 2 PRODUCTS

2.1 **FLOW METERS**

A. Manufacturers:
   1. EMCO
   2. Spirex Sarco - Model Vortex PHD
B. Flowmeter shall be constructed with a stainless-steel body, with integral transmitter and direct-reading scale. Flowmeter shall have a pressure rating of 1000 psig minimum with a temperature rating of 500 deg F minimum.
C. Display shall give visual, instantaneous rate of flow with integral transformer for low-voltage power operation. Accuracy shall be plus or minus 7/10 percent for liquids and 1-1/4 percent for gases. Output shall be 4-20 mA with pulse output for DDC control system to interface.

2.2 PRESSURE GAUGES

A. Manufacturers:
   1. Trerice.
   2. Weksler.
   3. Weiss.
   4. Winter.
B. Pressure Gauges: ASME B40.100, UL 393 metal case, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
   1. Case: Stainless Steel.
   2. Size: 4-1/2 inch diameter.
   3. Mid-Scale Accuracy: One percent.
   4. Scale: Psi.

2.3 PRESSURE GAUGE TAPPINGS

A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.
B. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.
C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.
D. Syphon: Steel, Schedule 40, 1/4 inch angle or straight pattern.

2.4 STEM TYPE THERMOMETERS

A. Manufacturers:
   1. Trerice
   2. Weiss
   3. Weksler Glass Thermometer Corp: www.wekslerglass.com.
   4. WIKA
   5. Winters

B. Thermometers - Light powered digital type with solar panels and LCD digits. Thermometers shall be ABS plastic cased and shall be provided with a calibration adjustment. Similar to Weiss Vari-angle Digital Thermometers or WIKA Solar Industrial Thermometers.
   1. Size: 9 inch case.
   2. Window: Clear Lexan.
   3. Accuracy: 2 percent, per ASTM E77.
   4. Calibration: Degrees F.

2.5 THERMOMETER SUPPORTS

A. Socket/Thermowell: Brass separable sockets/thermowell for thermometer stems with or without extensions as required, and with cap and chain.

2.6 TEST PLUGS

A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

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

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. All pressure gauges on water systems shall be installed with a 1/4" isolation ball valve and filter type pressure snubber.

E. All pressure gauges on steam systems shall be installed with a 1/4" isolation ball valve and pigtail siphon filled with water.

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

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

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

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

J. Locate test plugs adjacent thermometers and thermometer sockets.

END OF SECTION

SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Ball valves.
B. Butterfly valves.
C. Check valves.
D. Chainwheels.

1.2 REFERENCE STANDARDS

A. API STD 594 - Check Valves: Flanged, Lug, Wafer, and Butt-Welding; 2022.
B. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
C. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
D. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
F. ASME B31.9 - Building Services Piping; 2020.
G. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2025, with Errata.
H. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).
I. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service; 2021.
J. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
K. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017 (Reapproved 2025).
L. AWWA C606 - Grooved and Shouldered Joints; 2022.
M. MSS SP-45 - Drain and Bypass Connections; 2020.
N. MSS SP-67 - Butterfly Valves; 2022.
O. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.
P. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
Q. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
C. Closeout Documents:
   1. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.4 QUALITY ASSURANCE

A. Manufacturer:
   1. Obtain valves for each valve type from single manufacturer.

2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.

B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

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. Handle large valves with sling, modified to avoid damage to exposed parts.
2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.1 APPLICATIONS

A. See drawings for specific valve locations.

B. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).

C. Provide the following valves for the applications if not indicated on drawings:
1. Throttling (Hydronic): Butterfly, Ball, and Globe.
2. Isolation (Shutoff): Butterfly, Gate, and Ball.
3. Swing Check (Pump Outlet):
a. Size 2 inch and Smaller: Bronze with bronze disc.
b. 2-1/2 NPS and Larger: Iron with center-guided metal or center-guided with resilient seat.
4. Dead-End: Butterfly, single-flange (lug) type.

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

E. Required Valve End Connections for Non-Wafer Types:
1. Steel Pipe:
a. Size 2 inch and Smaller: Threaded ends.
b. 2-1/2 NPS and Larger: Grooved or flanged ends.
2. Copper Tube:
a. Size 2 inch and Smaller: Threaded ends, except solder-joint valve-ends.
b. Size 2-1/2 inch and Larger: Grooved ends.

3. Steam and Steam Condensate Pipe: Grooved ends not acceptable.

F. Heating Hot Water Valves:

1. 2 NPS and Smaller, Bronze Valves:
   a. Threaded or soldered ends.
   b. Ball: Full port, two piece, brass trim.
   c. Swing Check: Bronze disc, Class 125.
   d. Gate: NRS, Class 125.
2. Size 2-1/2 inch and Larger, Iron Valves:
   a. 2-1/2 inch to 4 inch: Threaded or flanged ends.
   b. Ball: 2-1/2 inch to 10 inch, Class 150.
   c. Single-Flange Butterfly: 2-1/2 inch to 12 inch, aluminum-bronze disc, EPDM seat, 200 CWP.
   d. Grooved-End Butterfly: 2-1/2 inch to 12 inch, 175 CWP.
   e. Swing Check: Metal seats, Class 125.
   f. Swing Check: 2-1/2 inch to 12 inch, lever and spring closure control, Class 125.
   g. Grooved-End Swing Check: 3 inch to 12 inch, 300 CWP.
   h. Plate-Type Check: Single plate, metal seat, Class 125 .
   i. Gate: NRS, Class 125.

2.2 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 Actuator Types:

1. Gear Actuator: Quarter-turn valves 8 inch and larger.
2. Handwheel: Valves other than quarter-turn types.
3. Hand Lever: Quarter-turn valves 6 NPS and smaller.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

D. Valves in Insulated Piping: Provide 2 inch stem extensions 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. Butterfly Valves: Extended neck.
4. Memory Stops: Fully adjustable after insulation is installed.

E. Memory Stops: Fully adjustable after insulation is installed.

F. Valve-End Connections:

1. Threaded End Valves: ASME B1.20.1.
2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
3. Pipe Flanges and Flanged Fittings 1/2 inch through 24 inch: ASME B16.5.
4. Solder Joint Connections: ASME B16.18.

5. Grooved End Connections: AWWA C606.

G. General ASME Compliance:

1. Building Services Piping Valves: ASME B31.9.

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.

K. Press-Fit Valve Manufacturers

1. Watts
2. Viega
3. Milwaukee
4. Apollo
5. NIBCO

L. Valve Manufacturers (unless otherwise noted)

1. Apollo Valves
2. NIBCO
3. Milwaukee
4. Watts

2.3 BRONZE, BALL VALVES

A. General:

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

B. Two Piece, Full Port with Bronze or Brass Trim:

1. Comply with MSS SP-110.
2. WOG Rating: 400 psi.
3. Body: Forged bronze or dezincified-brass alloy.
4. End Connections: Pipe thread or solder.
5. Seats: PTFE.
6. Stem: Bronze or brass.
7. Ball: Chrome plated brass.

2.4 IRON, GROOVED-END BUTTERFLY VALVES

A. CWP Rating: 175 psi.

1. Comply with MSS SP-67, Type I.
2. Body: Ductile iron.
3. Stem: Two-piece stainless steel.
4. Disc: Aluminum-bronze.
5. Disc Seal: EPDM.

2.5 BRONZE, LIFT CHECK VALVES

A. Class 125:

1. Comply with MSS SP-80, Type 1, Metal Disc to Metal Seat and Type 2, Nonmetallic Disc to Metal Seat.
2. CWP Rating: 200 psi.
3. Design: Vertical flow.
4. Body: Bronze.
5. Ends: Threaded.
6. Disc (Type 1): Bronze.
7. Disc (Type 2): PTFE.
8. Manufacturers

a. Apollo Valves

b. NIBCO

c. Milwaukee

d. Watts

2.6 BRONZE, SWING CHECK VALVES

A. Class 125:

1. Pressure and Temperature Rating: MSS SP-80, Type 3.
2. Design: Y-pattern, horizontal or vertical flow.
3. WSP Rating: 200 psi.
4. Body: Bronze, ASTM B62.
5. End Connections: Threaded or soldered.
6. Disc: Bronze.

2.7 IRON, FLANGED END SWING CHECK VALVES

A. Class 125:

1. 200 psi with metal seats and nonmetallic-to-metal seats.

B. Characteristics

1. Comply with MSS SP-71, Type I.
2. Design: Clear or full waterway with flanged ends.
3. Body: Gray iron with bolted bonnet in accordance with ASTM A126.
4. Trim: Bronze.
5. Disc Holder: Bronze.
6. Disc: PTFE or TFE.
7. Gasket: Asbestos free.

C. Manufacturers:

1. Apollo Valves
2. NIBCO
3. Milwaukee
4. Watts

2.8 IRON, SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125:

1. Comply with MSS SP-71, Type I.
2. Body Design: Clear or full waterway.
3. Body Material: ASTM A126, gray iron with bolted bonnet.
4. Ends: Flanged.
5. Trim: Bronze.
6. Gasket: Asbestos free.
7. Closer Control: Factory installed, exterior lever, and spring.
8. Manufacturers:
   a. Apollo Valves

   b. NIBCO

   c. Milwaukee

   d. Watts

2.9 IRON, GROOVED-END SWING CHECK VALVES

A. Class 300:
1. CWP Rating: 300 psi.
2. Body Material: ASTM A536, Grade 65-45-12 ductile iron.
3. Seal: EPDM or Nitrile.
4. Disc: Ductile iron.
5. Coating: Black, non-lead paint.

2.10 IRON, PLATE-TYPE CHECK VALVES

A. Class 125 Single-Plate:
1. Comply with API STD 594.
2. Sizes 2-1/2 to 12 inch: CWP Rating; 200 psi.
3. Sizes 14 to 24 inch: CWP Rating; 150 psi.
4. Body Design: Wafer, spring-loaded plate.
5. Body Material: ASTM A126, gray iron.
6. Resilient Seat: EPDM or NBR.

2.11 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to ball, butterfly, and Gate valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

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. Should valve is determined to be defective, replace with new valve.

3.2 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
C. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
D. 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 and center-guided into horizontal or vertical position, between flanges.
E. Provide chainwheels on operators for valves 4 inch NPS and larger where located 96 inches or more above finished floor, terminating 60 inches above finished floor.

END OF SECTION

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Nameplates.
B. Tags.
C. Stencils.
D. Pipe/Duct markers.
E. Ceiling markers.

1.2 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.
B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2025.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Product Data: Provide manufacturers catalog literature for each product required.
C. Closeout Documents:
   1. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
   2. Manufacturer's Installation Instructions: Indicate special procedures, and installation.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

A. Air Handling Units: Nameplates.
B. Air Terminal Units: Nameplates.
C. Automatic Controls: Tags. Key to control schematic.
D. Control Panels: Nameplates.
E. Dampers: Ceiling tacks, where located above lay-in ceiling.
F. Ductwork: Stencilled painting.
G. Heat Transfer Equipment: Nameplates.
H. Instrumentation: Tags.
I. Major Control Components: Nameplates.
J. Piping: Pipe Markers.
K. Pumps: Nameplates.
L. Tanks: Nameplates.
M. Thermostats: Tags.
N. Valves: Tagsand/or ceiling tacks where located above a finished ceiling..

2.2 NAMEPLATES

A. Manufacturers:
   1. Brimar Industries, Inc: www.pipemarker.com/#sle.
   2. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
   3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.

4. Seton Identification Products, a Tricor Direct Company: www.seton.com.

B. Letter Color: White.

C. Letter Height: 1/2 inch.

D. Background Color: Black.

E. Plastic: Comply with ASTM D709.

2.3 TAGS

A. Manufacturers:

1. Brady Corporation: www.bradycorp.com.
2. Brimar Industries, Inc: www.pipemarker.com/#sle.
3. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
5. Seton Identification Products, a Tricor Company: www.seton.com.

B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.

C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.4 STENCILS

A. Stencils: With clean cut symbols and letters of following size:

1. Ductwork and Equipment: 2-1/2 inch high letters.

B. Stencil Paint: As specified in Division 09 semi-gloss enamel, colors complying with ASME A13.1.

2.5 PIPE MARKERS

A. Manufacturers:

1. Brady Corporation: www.bradycorp.com.
2. Brimar Industries, Inc: www.pipemarker.com/#sle.
3. Craftmark Pipe Markers: www.craftmarkid.com/#sle.
4. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
5. Seton Identification Products, a Tricor Company: www.seton.com.

B. Color: Comply with ASME A13.1.

C. 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.

D. Color code as follows:

1. Heating, Cooling, and Boiler Feedwater: Green with white letters.
2. Toxic and Corrosive Fluids: Orange with black letters.
3. Compressed Air: Blue with white letters.
4. Flammable and oxidizing fluids: Yellow with black letters.

2.6 **CEILING MARKERS**

A. Manufacturers:

1. Craftmark: www.craftmarkid.com.
2. Moore
3. Seton

B. Description: Steel with 3/4 inch diameter color coded head.

1. Color code as follows:
   a. HVAC Equipment: Yellow.
   b. Fire Dampers and Smoke Dampers: Red.

c. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

A. Piping shall be identified as to contents using the following list:

Glycol Hot Water Heating Supply	GHWS
Glycol Hot Water Heating Return	GHWR
Natural Gas	NAT GAS
Refrigerant Liquid	RL
Refrigerant Suction	RS

B. Ductwork shall be identified as indicated below. Ductwork label shall also include the equipment served.

Supply Air	Supply
Return Air	Return
Exhaust Air	Exhaust
Outside Air	Outside
Relief Air	Relief
Grease Exhaust Air	Grease Exhaust

C. Valves controlling mains, risers and branches, but not individual shut-off or local control valves on equipment, shall be identified by a tag. Schedules, framed under glass and mounted where directed, shall be provided showing a complete listing of all valve tags and giving numbers, locations, and color codes, if any, of pipes controlled. Frames shall be secured to wall by not less than four screws.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 with corrosion resistant chain.

E. Install plastic pipe and duct markers in accordance with manufacturer's instructions.

F. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

G. Equipment serving different areas of a building other than where they are installed shall be permanently marked in an approved manner that uniquely identifies the equipment and the area it serves.

H. Locate duct markers where ductwork is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed locations as follows:

1. Near each damper.
2. Near each branch connection. Mark flow direction at each branch.
3. On both sides of penetrations through walls, floors, ceilings, and non-accessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed ductwork.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in congested areas where ductwork is partially hidden by other pipe, ductwork or equipment.
7. On both sides of every change in direction.
8. When several ducts from different units are located in concealed congested areas, locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
9. Provide a minimum one label per pipe/duct per room. Where pipes are racked, install pipe markers on each pipe in the same location to aid in differentiating each pipe in the rack.

I. For insulated pipe/duct, marker size shall be based on insulation size, not pipe/duct size.

1. Identify service, flow direction, and pressure.

J. Locate ceiling tacks/markers to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.

B. Testing, adjustment, and balancing of hydronic and Domestic Water systems.

C. Measurement of final operating condition of HVAC systems.

1.2 REFERENCE STANDARDS

A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition; 2016.

B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2024, with Errata (2025).

C. NEBB (TAB) - Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems; 2019, with Errata (2022).

D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2023.

1.3 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing agent who conforms to the standards set forth by either AABC, NEBB or TABB.

1.4 PREINSTALLATION CONFERENCE

A. Testing, Adjusting and Balancing Conference: Meet with the Owner's and the Architect's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, HVAC controls Installer, and other support personnel. Provide 7 days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
   a. Submittal distribution requirements.
   b. Contract Documents examination report.
   c. Testing, adjusting, and balancing plan.
   d. Work schedule and Project site access requirements.
   e. Coordination and cooperation of trades and subcontractors.
   f. Coordination of documentation and communication flow.

1.5 **COORDINATION**

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Provide 7 days' advance notice for each test. Include scheduled test dates and times.

C. Perform testing adjusting and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.6 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.

B. Shop Drawings:

1. Prior to testing, adjusting and balancing the system, the Contractor shall submit 2 copies of the proposed test report forms for engineer's approval.
2. Certified Testing, Adjusting and Balancing Reports: Submit 2 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.
3. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.. Submit 2 copies of the NEBB or AABC certificate for each member of the testing, adjusting, and balancing Agent team
4. TAB Plan: Submit 2 copies of a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
   a. Submit to Engineer.

5. Include at least the following in the plan:
   a. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.

   b. Identification and types of measurement instruments to be used and their most recent calibration date.

   c. Final test report forms to be used.

   d. Procedures for formal deficiency reports, including scope, frequency and distribution.

C. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

D. Closeout Documents:

1. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
   a. Units of Measure: Report data in I-P (inch-pound) units only.

   b. Include the following on the title page of each report:

      1) Name of Testing, Adjusting, and Balancing Agency.

      2) Address of Testing, Adjusting, and Balancing Agency.

      3) Telephone number of Testing, Adjusting, and Balancing Agency.

      4) Project name.

      5) Project location.

      6) Project Engineer.

      7) Project Engineer.

      8) Project Contractor.

9) Project altitude.

10) Report date.

11) Signature of testing, adjusting, and balancing Agent who certifies the report.

c. In addition to the certified field report data, include the following;

1) Pump curves,

2) Fan curves.

d. Summary of contents, including the following:

1) Design versus final performance.

2) Notable characteristics of systems.

e. Description of system operation sequence if it varies from the Contract Documents.

f. Notes to explain why certain final data in the body of reports vary from design values.

2. Instrument Calibration Reports: For instrument calibration, include the following:
   a. Instrument type and make

   b. Serial number.

   c. Application.

   d. Dates of use.

   e. Dates of calibration.

3. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

1.7 WARRANTY

A. Test and balance agency shall include an extended warranty of 90 days, after completion of the test and balance work, during which time the Engineer at his discretion may request a recheck, or resetting of any outlet, supply air fan, or exhaust fan as listed in test report. The agency shall provide technicians to assist the Engineer in making any tests he may require during this period of time.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
   1. AABC (NSTSB), AABC National Standards for Total System Balance.
   2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
   3. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
   4. SMACNA (TAB).
   5. Maintain at least one copy of the standard to be used at project site at all times.

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

D. TAB Agency Qualifications:

1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
2. Having minimum of three years documented experience.
3. Certified by one of the following:
   a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guarantee.
   b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
   c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.

E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.2 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
2. Systems are started and operating in a safe and normal condition.
3. Temperature control systems are installed complete and operable.
4. Proper thermal overload protection is in place for electrical equipment.
5. Final filters are clean and in place. If required, install temporary media in addition to final filters.
6. Duct systems are clean of debris.
7. Fans are rotating correctly.
8. Fire and volume dampers are in place and open.
9. Air coil fins are cleaned and combed.
10. Access doors are closed and duct end caps are in place.
11. Air outlets are installed and connected.
12. Duct system leakage is minimized.
13. Hydronic systems are flushed, filled, and vented.
14. Pumps are rotating correctly.
15. Proper strainer baskets are clean and in place.
16. Service and balance valves are open.
17. Examine automatic temperature system components to verify the following:
    a. Dampers, valves, and other controlled devices operate by the intended controller.
    b. Dampers and valves are in the position indicated by the controller.
    c. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in mixing boxes, and variable-air-volume terminals.
    d. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.

e. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.

f. Sensors are located to sense only the intended conditions.

g. Sequence of operation for control modes is according to the Contract Documents

h. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.

i. Interlocked systems are operating.

j. Changeover from heating to cooling mode occurs according to design values.

18. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project record documents described in Division 1 Section "Project Record Documents."

D. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems-Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

E. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

F. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

A. Any changing of pulley sizes if found necessary when testing systems, shall be done by this contractor. Any additional dampers which may be found necessary to get proper air supply and quantity shall be furnished by this contractor at no expense to the Owner

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so design conditions for system operations can be met.

3.4 ADJUSTMENT TOLERANCES

A. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

B. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.5 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:

1. Running log of events and issues.
2. Discrepancies, deficient or uncompleted work by others.
3. Contract interpretation requests.
4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

3.6 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

M. Balancing dampers shall be adjusted to minimize noise through VAV box by adjusting the balancing damper as required so the motorized damper in the VAV box is no greater than 25% closed to achieve minimum design airflow rate. Balancing damper handles shall be secured once balancing is completed to ensure dampers will remain in place after balancing is complete. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

N. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

O. On fan powered VAV boxes, adjust air flow switches for proper operation.

3.7 WATER SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.8 **VARIABLE FREQUENCY DRIVES/ECM MOTORS**

A. Variable Frequency Drives (VFD) and/or ECM motors are installed on some of the fans on the job. Each fan VFD/ECM motor may be used to balance the airflow. The fan shall be resheaved as necessary to have the balanced airflow discharged with the VFD set at 60 Hz (ECM motor at 100%). Coordinate resheaving necessary with Mechanical Contractor

B. Variable Frequency Drives (VFD) and/or ECM motors are installed on some of the pumps on the job. Each pump VFD/ECM motor may be used to balance the waterflow. False head shall not be placed on the system with a balancing valve in order to get the pump to run at 60 Hz/100%.

3.9 **ADDITIONAL TESTS**

A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near - peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-- peak summer and winter conditions.

3.10 **PRESSURE TESTING OF DUCTWORK**

A. The balancing subcontractor shall be responsible for pressure test verification of the entire ventilation system for leakage. Supply all necessary equipment to pressure test duct work. Pressure testing shall take place during construction as required, in accordance with Section 23 31 00

B. Testing supply duct work shall be done as follows: After the duct work is fabricated and installed, it shall be isolated in sections and tested for air tightness. The air pressure used for the test shall match that specified under Section 23 31 00. The ductwork shall be tested to a pressure class A as described per SMACNA. The ductwork shall be tested so that the sealing of the ductwork shall be a leakage class 6. This means that 6 CFM of leakage per 100 sq ft of duct surface is the maximum allowable threshold if tested at 1 inch test pressure. See additional duct sealing requirements in the latest edition SMACNA manual “HVAC Air Duct Leakage Test Manual.” Do this prior to applying any thermal insulation. In testing for air tightness, the main trunk shall be first tested by blanking off all branch take-offs, then each branch shall be tested individually after main trunk is proven to be air tight. No equipment connections shall be made on ends of branches until after testing. Ends and other branches shall be blanked off with air tight seals made of galvanized blanks taped in place or other approved methods. Soap solution brushed on shall be used where necessary to detect small leaks.

C. The balancing contractor performing the leakage testing shall utilize a small scale drawing to show which ductwork corresponds to the duct testing data. This drawing shall individually number each section of ductwork being tested and be included in the final duct pressure testing and balancing report.

D. Duct pressure testing report shall include the following information:

1. The date of the test.
2. The project name.
3. A description of the duct being tested (identification of duct from small scale plan as called out above), sealing classification and duct classification.
4. The design and actual test static pressures.
5. The design and actual leakage rate.
6. Calculation of duct leakage rate.
7. If the duct passed or failed.
8. Description of the apparatus utilized during testing including orifice size, manufacturer and date calibrated.
9. The actual orifice pressure drop with the actual flow.
10. The name of the person performing the test and any witnesses.

3.11 SCOPE

A. Test, adjust, and balance the following:

1. Plumbing Pumps.
2. Domestic Hot Water Recirculation System
3. HVAC Pumps.
4. Roof Top Air Handling Units.
5. Air Coils.
6. All flow meters.
7. Air Handling Units.
8. Fans.
9. Air Filters.
10. Air Terminal Units.
11. Air Inlets and Outlets.
12. Kitchen Hoods.

3.12 MINIMUM DATA TO BE REPORTED

A. Electric Motors:

1. Manufacturer.
2. Model/Frame.
3. HP/BHP.
4. Phase, voltage, amperage; nameplate, actual, no load.
5. RPM.
6. Service factor.
7. Starter size, rating, heater elements.
8. Sheave Make/Size/Bore.

B. V-Belt Drives:

1. Identification/location.
2. Required driven RPM.
3. Driven sheave, diameter and RPM.
4. Belt, size and quantity.
5. Motor sheave diameter and RPM.
6. Center to center distance, maximum, minimum, and actual.

C. Pumps:

1. Identification/number.
2. Manufacturer.
3. Size/model.
4. Impeller.
5. Service.
6. Design flow rate, pressure drop, BHP.

7. Actual flow rate, pressure drop, BHP.
8. Discharge pressure.
9. Suction pressure.
10. Total operating head pressure.
11. Shut off, discharge and suction pressures.
12. Shut off, total head pressure.

D. Cooling Coils:

1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Entering air DB temperature, design and actual.
7. Entering air WB temperature, design and actual.
8. Leaving air DB temperature, design and actual.
9. Leaving air WB temperature, design and actual.
10. Saturated suction temperature, design and actual.
11. Air pressure drop, design and actual.

E. Heating Coils:

1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Water flow, design and actual.
7. Water pressure drop, design and actual.
8. Entering water temperature, design and actual.
9. Leaving water temperature, design and actual.
10. Entering air temperature, design and actual.
11. Leaving air temperature, design and actual.
12. Air pressure drop, design and actual.

F. Air Moving Equipment:

1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Arrangement/Class/Discharge.
6. Air flow, specified and actual.
7. Return air flow, specified and actual.
8. Outside air flow, specified and actual.
9. Total static pressure (total external), specified and actual.
10. Inlet pressure.
11. Discharge pressure.
12. Sheave Make/Size/Bore.
13. Number of Belts/Make/Size.
14. Fan RPM.

G. Return Air/Outside Air:

1. Identification/location.
2. Design air flow.
3. Actual air flow.
4. Design return air flow.
5. Actual return air flow.
6. Design outside air flow.

7. Actual outside air flow.
8. Return air temperature.
9. Outside air temperature.
10. Required mixed air temperature.
11. Actual mixed air temperature.
12. Design outside/return air ratio.
13. Actual outside/return air ratio.

H. Exhaust Fans:

1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Air flow, specified and actual.
6. Total static pressure (total external), specified and actual.
7. Inlet pressure.
8. Discharge pressure.
9. Sheave Make/Size/Bore.
10. Number of Belts/Make/Size.
11. Fan RPM.

I. Duct Traverses:

1. System zone/branch.
2. Duct size.
3. Area.
4. Design velocity.
5. Design air flow.
6. Test velocity.
7. Test air flow.
8. Duct static pressure.
9. Air temperature.
10. Air correction factor.

J. Duct Leak Tests:

1. Description of ductwork under test.
2. Duct design operating pressure.
3. Duct design test static pressure.
4. Duct capacity, air flow.
5. Maximum allowable leakage duct capacity times leak factor.
6. Test apparatus:
    a. Blower.
    b. Orifice, tube size.
    c. Orifice size.
    d. Calibrated.
7. Test static pressure.
8. Test orifice differential pressure.
9. Leakage.

K. Terminal Unit Data:

1. Manufacturer.
2. Type, constant, variable, single, dual duct.
3. Identification/number.
4. Location.

5. Model number.
6. Size.
7. Minimum static pressure.
8. Minimum design air flow.
9. Maximum design air flow.
10. Maximum actual air flow.
11. Inlet static pressure.

L. Air Distribution Tests:

1. Air terminal number.
2. Room number/location.
3. Terminal type.
4. Terminal size.
5. Area factor.
6. Design velocity.
7. Design air flow.
8. Test (final) velocity.
9. Test (final) air flow.
10. Percent of design air flow.

M. Kitchen Hoods

END OF SECTION

SECTION 23 07 13 - DUCT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Duct insulation.

B. Duct liner.

1.2 REFERENCE STANDARDS

A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

B. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.

C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).

D. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2025.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

F. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.

G. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015.

H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.

B. Shop Drawings:

1. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

1.6 FIELD CONDITIONS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 GLASS FIBER, FLEXIBLE

A. Manufacturer:

1. Knauf Insulation: www.knaufinsulation.com.

2. Johns Manville: www.jm.com.
3. Owens Corning Corporation: www.ocbuildingspec.com.

B. Insulation: ASTM C553; flexible, noncombustible blanket.

1. K value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
2. Maximum Service Temperature: 250 degrees F.
3. Maximum Water Vapor Absorption: 5.0 percent by weight.

C. Vapor Barrier Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with pressure-sensitive tape.

D. Vapor Barrier Tape:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

2.3 GLASS FIBER, RIGID

A. Manufacturer:

1. Knauf Insulation: www.knaufinsulation.com.
2. Johns Manville: www.jm.com.
3. Owens Corning Corporation: www.ocbuildingspec.com/sle.

B. Insulation: ASTM C612; rigid, noncombustible blanket.

1. K Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
2. Maximum Service Temperature: 450 degrees F.
3. Maximum Water Vapor Absorption: 5.0 percent.
4. Maximum Density: 8.0 pcf.

C. Vapor Barrier Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with pressure-sensitive tape.

D. Vapor Barrier Tape:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

2.4 FIRE RATED DUCT WRAP INSULATION

A. Manufacturers:

1. FireMaster Fast Wrap+
2. 3M Fire Barrier Duct Wrap 615+

B. Lightweight, non-asbestos, high temperature, bio-soluble, calcium-magnesium-silicate (CMS) non-woven blanket, encapsulated in a scrim-reinforced foil, blanket thickness of 1.5 inches for ventilation and grease duct applications.

1. Color: White blanket, aluminum foil encapsulated.
2. Weight: 0.9 psf .
3. Density: 6 pcf nominal.
4. Thermal Conductivity (k-value) at 500 Degrees F (ASTM C411, ASTM C518): 0.48 Btu/(ft2 × h × F).
5. R-Value per ASTM C 518 at ambient 77 F: at least 6.3 (F-ft2-hr / Btu)
6. Service range up to 2000ºF.
7. Fire Resistance: For use in 1 hour fire resistant systems.
8. Product complies with ASTM E 2336 test standard.
9. Product complies with ISO 6944 test standard.
10. Through-penetration per ASTM E 814 (UL 1479)
11. Non-combustible per ASTM E 136

C. Tape:

1. High performance filament tape, 3M No. 898 1 inch wide.
2. FSK Facing Tape with aluminum foil, fiberglass scrim, kraft paper backing: nominal 4 inches wide, 3M No. 3320.

D. Banding Material: Stainless or carbon steel banding: 1/2 inch wide X 0.015 inch thick, as stated in duct wrap Design Listing.

E. Insulation pins and clips:

1. Copper-coated steel pins, 12 gauge with a minimum length of 4 inches with square galvanized steel speed clips: 2.5 inch (.
2. 12 gauge insulated cup head steel pins.

F. Through-penetration firestop materials:

1. Packing materials: Pieces of 3M Fire Barrier Duct Wrap, or 4 pcf mineral wool.
2. Sealants: 3M Fire Barrier: 1000 NS non-slump silicone sealant, 1003 SL self-leveling silicone sealant, 2000+ premium non-slump silicone sealant, or CP 25WB+ premium intumescent latex caulk, as stated in firestop Design Listing.

2.5 DUCT LINER

A. Manufacturers:

1. Armacell LLC: www.armacell.us/#sle.
2. Knauf Insulation: www.knaufinsulation.com.
3. Johns Manville: www.jm.com.

B. Flexible duct liner shall be installed in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible (latest edition) except as modified herein.

C. Duct liner shall have a minimum sound absorption coefficient of .55 at 1/2" thickness, factory applied edge coating, shall not support mold or fungus growth, shall meet U.L. #181 erosion test

D. The air stream surface mat of all duct liner shall be treated with an EPA registered anti microbial agent to prevent fungal or bacterial growth.

E. Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; flexible blanket, rigid board, and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.

1. Fungal Resistance: No growth when tested according to ASTM G21.
2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
3. Service Temperature: Up to 250 degrees F.
4. Density: 1-1/2 pound.
5. Minimum Noise Reduction Coefficients:
   a. 1/2 inch Thickness: 0.30.
   b. 1 inch Thickness: 0.45.
   c. 1-1/2 inches Thickness: 0.60.
   d. 2 inch Thickness: 0.70.

PART 3 EXECUTION

3.1 EXAMINATION

A. Test ductwork for design pressure prior to applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NAIMA National Insulation Standards.

C. Supply duct shall mean all supply ducts from air handling unit discharge to air outlet (diffuser, register, etc.). This includes all non insulated devices such as terminal coils, distribution boxes, air flow measuring stations, sound attenuators, linear slot plenums, etc. installed in the supply or return duct system. Duct insulation shall extend uninterrupted through all walls with the exception of those containing fire and/or smoke dampers. Coordinate with the installing mechanical contractor(s) at the start of the project to ensure holdouts in walls, where required, are oversized to allow for full insulation thickness to be applied.

D. All supply ducts passing through spaces without ceilings and not feeding that space shall be insulated as specified.

E. HVAC ductwork routed exposed in the area it serves shall not be insulated with the following exceptions:
   1. High temperature process air ductwork shall be insulated as described above.
   2. Ductwork with air temperatures below 50 degrees F shall be insulated as described elsewhere in this section.
   3. HVAC ductwork in spaces with garage door openings directly to the building exterior shall be insulated as described above.

F. Insulated ducts conveying air above and below ambient temperature:
   1. Provide insulation with vapor barrier jackets.
   2. Finish with tape and vapor barrier jacket.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

G. Ducts Exposed in Mechanical Equipment Rooms or ducts exposed in all other spaces (below 8-feet above finished floor): Finish with rigid fiberglass.

H. Glass fiber - flexible installation:
   1. End and longitudinal joints shall be butted firmly and lapped and sealed by adhesive.
   2. Mechanical fasteners shall be installed on sides and bottom of ducts spaced at the rate of not less than one fastener per two lineal feet.
   3. A single mechanical fasteners shall be installed on any duct width of 24” or larger, two fasteners for 48” or larger, three fasteners for 72” or larger, etc.
   4. At all joints, the vapor barrier jackets shall be covered with 5" wide pressure sensitive vapor seal tape, or shall have 2.5" wide laps drawn tight, stapled, and secured with vapor barrier adhesive.
   5. The joints and all openings where facing is pierced or punctured by pins, staples, etc. shall be coated with two inch wide strips of vapor barrier coating compound.

I. Glass fiber - rigid installation:
   1. Rigid board fiberglass shall be furnished with a reinforced foil faced vapor barrier jacket. Insulation shall be protected at corners and edges with metal corner strips or clips.

J. Fire Wrap Application:
   1. Kitchen Exhaust Grease Ducts: Install fire resistive duct wrap insulation in direct contact with ductwork to Manufacturer's instructions and referenced standards, to applicable Omega Point Laboratories design numbers, including listed penetration firestop system.
      a. For kitchen exhaust grease ducts, regardless of fire rating, provide two layers of Fire Barrier Duct Wrap with 3 inch overlaps, , tape seams using minimum 3 inch wide aluminum foil adhesive tape.

   2. Finish installation using 1/2 inch wide by 0.015 inch steel banding on exterior layer of wrap. Spacing 10.5 inches on center and within 1.5 inches of all overlapped seams. Consult individual listings for approved banding type.
   3. Duct Widths Greater than 24 Inches: Weld insulation pins to bottom of horizontal ducts on a 12 inch by 10.5 inch maximum grid spacing. Welded insulation pins to one of the wider sides of all vertical ducts on a 12 inch by 10.5 inch maximum grid spacing. Impale duct wrap insulation over pins and secure with speed clips.
   4. Duct Access Doors: Install duct wrap to Manufacturer's instructions and procedures.
   5. Firestopping At Fire Separations:

a. Firestop all wrapped ductwork penetrating fire rated concrete floors, gypsum board, block and concrete wall assemblies and gypsum board shaftwall assemblies using UL and/or Omega Point Laboratories firestop system Listings appropriate for the applicable duct wrap system .

b. Kitchen exhaust grease ducts: Fire resistive duct wrap insulation to be continuous through wall or floor penetrations. Minimum 0.5 inch, maximum 4.5 inch clearance permitted between outer layer of duct wrap insulation and edge of opening. Fill annular space between edge of opening and wrapped duct with pieces of duct wrap insulation or mineral wool insulation firmly packed into opening. Compress to percentage stated and minimum depth stated in firestop listing. Recess packing material below surface on both sides of walls or top side only for floors to depth stated in firestop listing. Seal over packing material using firestop sealant to depth stated in firestop listing, flush with top side of floor and both sides of wall surfaces.

K. Duct and Plenum Liner Application:

1. Adhere insulation with adhesive for 100 percent coverage.
2. Seal and smooth joints. Seal and coat transverse joints.
3. Seal liner surface penetrations with adhesive.
4. Where duct liner is installed in ducts, the duct size indicated accommodates the liner such that the gross duct dimension is that shown on the drawings. No increase in duct size is necessary to accommodate duct liner thickness.
5. Casings requiring insulation on the inside shall have liner adhered to all sides of casing with a minimum of 50% coverage of adhesive. In addition, use mechanical fasteners such as Graham Welding Pins, Tuff-Weld Nylon hangers or Stick-Klips on maximum of 16" centers at top and sides. Caulk all joints with fire-retardant mastic to keep moving air from getting behind insulation.

3.3 SCHEDULES

A. **Air Handling Units**

Ductwork System	**Insulation Type**	**Insulation Thickness**	**Density**
Supply Duct	Glass fiber flexible	2.2 inch (R value - 6)	3/4 lb/ft^3
Return Duct	None	None	None
Outdoor Air Duct	Glass fiber rigid	3 inch	3 lb/ft^3

B. **Roof Mounted Air Handling Units**

Ductwork System	**Insulation Type**	**Insulation Thickness**	**Density**
Supply Duct	Glass fiber flexible	2.2 inch (R value - 6)	3/4 lb/ft^3
Return Duct	None	None	None

C. **Exhaust Fan Ductwork**

Ductwork System	**Insulation Type**	**Insulation Thickness**	**Density**
Exhaust Duct 10 feet back from isolation damper	Glass fiber flexible	2 inch	1-1/2 lb/ft^3

D. **Grease Exhaust Duct**

Ductwork System	**Insulation Type**	**Insulation Thickness**	**Density**

All Grease Ducts	Ceramic Fire Wrap	3 inch total (2 layers of 1-1/2 inch w/ staggered seams) 2	8 lb/ft^3

E. **Mechanical Room Ductwork** (tops of ducts may be 2” foil faced fiberglass in lieu of rigid only with approval from the engineer prior to the installation.)

Ductwork System	**Insulation Type**	**Insulation Thickness**	**Density**
Supply Duct	Glass fiber rigid	2 inch	3 lb/ft^3
Return Duct	None		
Outdoor Air Duct	Glass fiber rigid	3 inch	3 lb/ft^3
Exhaust Air Duct	Glass fiber rigid	2 inch	3 lb/ft^3

F. **Duct Liner**

1. All transfer air ducts.
2. All ducts as indicated by cross-hatching or as noted on the drawings.
3. Liner types for the various surfaces shall be as follows:
   a. Return air ductwork shall be lined with 1" thick coated fiberglass flexible duct liner.

   b. Transfer air ductwork shall be lined with 1" thick coated fiberglass flexible duct liner.

END OF SECTION

SECTION 23 07 16 - HVAC EQUIPMENT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Equipment insulation.

B. Jacketing and accessories.

1.2 REFERENCE STANDARDS

A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019, with Editorial Revision (2023).

B. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.

C. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2025.

D. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2024.

E. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.

G. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.

H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.

B. Shop Drawings:

1. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.6 FIELD CONDITIONS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 GLASS FIBER, RIGID

A. Manufacturer:
   1. CertainTeed Corporation: www.certainteed.com.
   2. Johns Manville Corporation: www.jm.com.
   3. Knauf Insulation: www.knaufusa.com.
   4. Owens Corning Corp: www.owenscorning.com.

B. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
   1. K Value: ___ at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
   2. Maximum Service Temperature: 850 degrees F.
   3. Maximum Water Vapor Absorption: 5.0 percent by weight.
   4. Maximum Density: 8.0 pcf.

2.3 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:
   1. Aeroflex USA, Inc: www.aeroflexusa.com.
   2. Armacell LLC: www.armacell.us.
   3. K-Flex USA LLC; Insul-Sheet: www.kflexusa.com/#sle.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
   1. Minimum Service Temperature: Minus 40 degrees F.
   2. Maximum Service Temperature: 220 degrees F.
   3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.4 JACKETING AND ACCESSORIES

A. PVC Plastic:
   1. Manufacturers:
      a. Johns Manville Corporation: www.jm.com.

   2. Jacket: Sheet material, off-white color.
      a. Minimum Service Temperature: Minus 40 degrees F.

      b. Maximum Service Temperature: 150 degrees F.

      c. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.

      d. Thickness: 10 mil, 0.010 inch.

      e. Connections: Brush on welding adhesive.

   3. Covering Adhesive Mastic: Compatible with insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that equipment has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Factory Insulated Equipment: Do not insulate.

C. Exposed Equipment: Locate insulation and cover seams in least visible locations.

D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.

F. Insulated equipment containing fluids below ambient temperature; insulate entire system.

G. Fiber glass insulated equipment containing fluids below ambient temperature; provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.

H. For hot equipment, insulate flanges and unions with removable sections and jackets.

I. Heating Systems Insulation:

1. Expansion tank(s), and air separator shall be insulated with pre-molded fiberglass pipe insulation (in thickness specified in piping insulation specification for steam or hot water), 4 lb. density. All seams shall be taped smooth. Ends shall be finished with mastic, troweled smooth.

J. Side Stream Filters serving Heating Water:

1. Insulate with a minimum of 1/2 inch elastomeric foam insulation, fully adheared.
2. Insulate entire body of filter possible without inhibiting access to servicing filter.
3. Ensure insulation is pointed to ensure water cannot get behind insulation.

K. Inserts and Shields:

1. Application: Equipment 2 inches diameter or larger.
2. Shields: Galvanized steel between hangers and inserts.
3. Insert Location: Between support shield and equipment and under the finish jacket.
   a. Heating Water:

      1) Pipe insulation protection saddle or shield shall be 22 gauge 3" piping or less, and 18 gauge for piping greater than 3" diameter, shall be provided at supports where pipe is supported by the insulation or inserts. The saddle shall be at minimum length of 10 inches.

4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range. Calcium Silicate shall not be used on low temp applications where condensation may occur.
6. Pipe supports for piping which operates above 250°F shall be high density calcium silicate insulation similar to Tru-Balance 1200E saddles as manufactured by Buckaroos, Inc.
7. Pipe supports for piping which operates below 250°F shall made be high density phenolic foam pipe insulation similar to Tru-Balance 2550FS saddles as manufactured by Buckaroos, Inc. Insulation in saddles shall meet ASTM E-84 ratings for 25 flame and 50 smoke.

L. Finish insulation at supports, protrusions, and interruptions.

M. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.

N. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

O. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

END OF SECTION

SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping insulation.
B. Flexible removable and reusable blanket insulation.
C. Jacketing and accessories.

1.2 REFERENCE STANDARDS

A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2019, with Editorial Revision (2023).
C. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2024).
D. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2022a.
E. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).
F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.
G. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.
H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 GLASS FIBER, RIGID

A. Manufacturers:
   1. CertainTeed Corporation: www.certainteed.com.
   2. Johns Manville Corporation: www.jm.com.
   3. Knauf Insulation: www.knaufinsulation.com.
   4. Owens Corning Corporation: www.ocbuildingspec.com/sle.
B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. K Value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum Service Temperature: 850 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.

4. Density 4 lb.

C. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
   1. K Value: ASTM C177, 0.23 at 75 degrees F.
   2. Maximum Service Temperature: 220 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.

D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

E. Vapor Barrier Lap Adhesive: Compatible with insulation.

F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.3 JACKETING AND ACCESSORIES

A. PVC Plastic.
   1. Manufacturers:
      a. Johns Manville Zeston 2000 Series White PVC or equal.

   2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
      a. Minimum Service Temperature: 0 degrees F.

      b. Maximum Service Temperature: 150 degrees F.

      c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.

      d. Connections: Brush on welding adhesive.

B. Aluminum Jacket (Exterior Applications):
   1. Manufacturers:
      a. Ideal Tape Co..

      b. _____.

   2. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
   3. Thickness: 0.016 inch sheet.
   4. Finish: Embossed.
   5. Joining: Longitudinal slip joints and 2 inch laps.
   6. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
   7. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

2.4 FITTING INSULATION:

A. For piping 1-1/2” and smaller, all valves, strainers, ball valves and balancing valves shall be insulated with standard pipe insulation in the thicknesses listed above.

B. For piping 2” and larger, all valves, strainers, ball valves and balancing valves shall be insulated with a factory fabricated removable and reusable cover.

C. Insulation shall have a minimum k- factor .26, using fiberglass blanket (or flexible elastomeric foam insulation if specified above). Flame and smoke spread shall be 25/50 per ASTM E-84.

D. Outer jacket shall be made of material equal to DuPont Tychem® QC, overlapping and completely covering the insulation with seams joined by tabs made from hook and loop fasteners (Velcro). Butt ends shall have sewn- in-place elastic.

E. Outer jacket shall overlap adjoining sections of pipe insulation.

F. Fitting jackets shall be as manufactured by No Sweat Valve Wraps, Inc., or approved equal.

2.5 REFRIGERATION PIPING INSULATION:

A. All refrigeration suction lines, liquid lines, hot gas lines, and hot gas by-pass lines both inside and outside the building shall be insulated with 3/4" thick flexible elastomeric foam insulation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Test piping for design pressure, liquid tightness, and continuity prior to applying insulation materials.
B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install in accordance with NAIMA National Insulation Standards.
C. Exposed Piping: Locate insulation and cover seams in least visible locations.
D. Insulated Pipes Conveying Fluids Below Ambient Temperature:
   1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
E. Glass Fiber Insulated Pipes Conveying Fluids Below Ambient Temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
F. Provide Elastomeric Foam Insulation for all piping concealed in equipment cabinets for fan coils, induction displacement units, and unit heaters. Insulation thickness shall be as noted in schedules below.
G. Flexible Elastomeric Foam Insulated Pipes Conveying Fluids Below Ambient Temperature:
   1. Insulation Installation on Straight Pipes and Tubes:
      a. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

      b. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

      c. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.

      d. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

   2. Insulation Installation on Pipe Flanges:
      a. Install preformed pipe insulation to outer diameter of pipe flange.

      b. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

      c. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.

d. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

3. Insulation Installation on Pipe Fittings and Elbows:
   a. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

   b. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

4. Insulation Installation on Valves and Pipe Specialties:
   a. Install preformed sections of cellular-glass insulation to valve body.

   b. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

   c. Install insulation to flanges as specified for flange installation application.

H. For hot piping, insulate flanges and unions at equipment.

I. Glass Fiber Insulated Pipes Conveying Fluids Above Ambient Temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied, or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

J. Inserts and Shields:
   1. All piping 1-1/2” and smaller, no insert is required below the insulation. Saddles shall be provided for all insulated piping. Both inserts and saddles shall be provided for all piping 2" and larger.
   2. A pipe insulation protection saddle of 22 gauge galvanized sheet metal for piping 3" diameter and smaller, and 18 gauge for piping larger than 3" diameter, shall be provided at supports where pipe is supported by the insulation or inserts. The saddle shall be at minimum length of 12 inches.
   3. Pipe supports for piping which operates below 250°F shall made be high density phenolic foam pipe insulation similar to Tru-Balance 2550FS saddles as manufactured by Buckaroos, Inc. Insulation in saddles shall meet ASTM E-84 ratings for 25 flame and 50 smoke.
   4. Insert Material (for piping that operates above 250 degrees F): Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

K. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 84 00.

L. Apply a PVC jacket to all exposed piping below 8' above finished floor in ALL rooms or spaces where occupants or staff can enter.

M. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

3.3 SCHEDULE

A. Glycol Heating Supply and Return Systems
   1. Supply and Return: Glass Fiber, Rigid.

Service	Pipe Size	Insulation Thickness
105F to 200F	1-1/4 inch and less	1-1/2 inch
	1-1/2 inch and greater	2 inch

2. For piping smaller than 1-1/2” and located in partitions within conditioned spaces, reduction of these thicknesses by 1” shall be permitted, but not to a thickness less than 1”.

B. Cooling Systems

Service	Pipe Size	Insulation Thickness
Refigeration Suction/Liquid/Hot Gas	All	3/4 inch Flexible Elastomeric Foam
Cooling Coil Condensate	All	3/4 inch Flexible Elastomeric Foam

END OF SECTION

SECTION 23 09 13 - INSTRUMENTS AND CONTROL ELEMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Control panels
B. Control valves.
C. Electronic valve actuators
D. Damper operators.
E. Temperature sensors
F. Humidity sensors
G. Outside air sensors
H. Duct mounted sensors
I. Pressure sensors
J. Differential pressure sensors
K. Carbon dioxide sensors
L. Refrigerant leak detectors
M. Status and safety switches
N. Variable Frequency Drive

1.2 REFERENCE STANDARDS

A. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
   2. Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system. For variable frequency drives: indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
C. Closeout Documents:
   1. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
   2. Project Record Documents: Record actual location of control components, including panels, thermostats, and sensors.
      a. Revise shop drawings to reflect actual installation and operating sequences.
   3. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this sectionwith minimum ten (10) years experience approved by manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store equipment in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle equipment in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

PART 2 PRODUCTS

2.1 EQUIPMENT - GENERAL

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.2 CONTROL PANELS

A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.

B. Provide a 120V power transformer and a convenience outlet within the cabinet.

C. NEMA EN 10250, general purpose utility enclosures with enameled finished face panel.

D. Provide common keying for all panels.

2.3 CONTROL VALVES

A. Control valves shall be 2-way or 3-way mixing (or diverting) as indicated in drawings. Pressure drop through water valves shall be 120% of the pressure drop through the controlled equipment. Pressure drop through medium pressure steam valves with atmospheric returns shall be 80% of inlet steam pressure.

B. Ball Valves, 1/2 through 2 in.:

1. Ball Valves shall have forged brass bodies. Valves shall have available either Chrome Plated Brass Balls or 300 Series Stainless Steel Balls in all sizes. Valves shall have available either Nickel Plated Brass Stems or 300 Series Stainless Steel Stems with a blow-out proof stem design in all sizes.
2. Valves shall have Graphite reinforced Polytetrafluoroethylene (PTFE) seats with Ethylene Propylene Diene Monomer (EPDM) O-ring backing. Stem seals shall be double EPDM O-rings.
3. Flow Characterization Disk shall be rated for 50 psid maximum differential pressure and shall be inserted against the casting of the valve.
4. All ball valves with internal pipe thread end connections shall be rated to 580 psi maximum static pressure at 203°F fluid temperature. All ball valves with sweat end connections or press end connection shall be rated to 300 psig maximum static pressure at 203°F fluid temperature
5. All valves shall be rated for service with hot water, chilled water and 50% glycol solutions. Ball Valves with stainless steel balls and stems shall be rated for use with 15 psig saturated steam. Valves shall be rated for 200 psid closeoff pressure. Flow Characteristics shall be equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.

C. Ball Valves, 2-1/2 through 4 in. Flanged:

1. Ball Valves shall have forged brass bodies with ASME Class 150 ductile iron flanges. Valves shall have 300 Series Stainless Steel Balls. Valves shall have 300 Series Stainless Steel Stems with a blow-out proof stem design.
2. Valves shall have Graphite reinforced Polytetrafluoroethylene (PTFE) seats with Ethylene Propylene Diene Monomer (EPDM) O-ring backing. Stem seals shall be double EPDM O-rings.
3. Flow Characterization Disk shall be rated for 50 psid maximum differential pressure. Flow Characteristics shall be equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.
4. All valves shall be rated for service with hot water, chilled water, 50% glycol solutions and rated for use with 25 psig saturated steam.

5. Two-Way Valves shall be rated for 100 psid closeoff pressure and Three-Way Valves shall be rated for 50 psid closeoff pressure.

D. Butterfly Valves, 2 through 20 in. resilient seat ASME Class 125/150 Flanged:
   1. Butterfly Valves shall have cast iron bodies and be fully lugged.
   2. Butterfly Valves seat shall be Ethylene Propylene Diene Monomer (EPDM). Butterfly Valve disk shall be Ductile Iron with Nylon 11 coating. Butterfly Valve stems shall be Stainless Steel. Flow Characteristics shall be equal percentage up to 70° of disk rotation.
   3. All valves shall be rated for service with hot water, chilled water and 50% glycol solutions.

E. Butterfly Valves, High Performance 2-1/2 through 16 in ASME Class 150 or 300:
   1. Butterfly Valves shall have bodies manufactured from Carbon Steel and shall be fully lugged.
   2. Butterfly Valves seat assembly shall be RPTFE (reinforced polytetrafluoroethylene) and the seat retainer shall be Carbon Steel. Butterfly Valve disk shall be Stainless Steel. Butterfly Valve stems shall be 17-4 PH Stainless Steel. Butterfly Valve Stem Seals shall be One Carbon Fiber Ring and Three TFE Rings.
   3. Flow Characteristics shall be equal percentage up to 70° of disk rotation.
   4. All valves shall be rated for service with hot water, chilled water, 50% glycol solutions and 50 psig saturated steam in modulating service or 150 psig saturated steam in two position service.

F. Globe Valves, Brass, 1/2 through 2 in.
   1. Valves shall have bodies manufactured from brass. Valves shall meet the pressure and temperature requirements of ANSI B16.15, Class 250.
   2. Valve stems shall be a 300 Series Stainless Steel. Valves with brass plug and seat shall have stem seals with Self-Adjusting Ethylene Propylene Rubber (EPR) Ring Pack U-Cups. Valves with Stainless Steel plug and seat shall valve stem seals with Spring Loaded Polytetrafluoroethylene (PTFE) and Elastomer V-Rings.
   3. Flow Characteristics shall be equal percentage for two-way valves and linear for three-way valves.

G. Globe Valves, Cast Iron, 2-1/2 through 6 in.
   1. Valves shall have bodies manufactured from cast iron. Valves shall meet the pressure and temperature requirements of ANSI B16.1, Class 125.
   2. Valve stems shall be a 316 Series Stainless Steel. Valves shall have stem seals with Ethylene Propylene Terpolymer (EPT) Ring Pack U-Cups
   3. Flow Characteristics shall be equal modified linear.

H. Temperature control valves shall be located within 24” and in the same room as the piece of equipment that it serves. This includes fin tube, unit heaters, coils, etc. Any deviation from this must be cleared with the contracting officer.

2.4 ELECTRONIC VALVE ACTUATORS

A. Select actuator for full shutoff at maximum pump differential pressure or for maximum torque required for proper damper close off. Actuators shall be either two position or modulating based on the sequence of operations.
   1. Two position actuators shall be provided with synchronous motor with enclosed gear train, dual-return springs, and valve-position indicator. Actuators shall fail to last position. Two position control valves shall be low pressure drop type valves.
   2. Modulating actuators shall be self-contained, linear motor, actuator with 60-second full travel, with transformer and single-throw, double-pole contacts. Actuators shall fail as noted below.

B. Valve actuators shall be UL-recognized or CSA-certified. Provide valve actuators as noted in the following:
   1. Provide spring return normally open actuators on air handling unit heating valves.
   2. Actuators serving steam valves and terminal devices shall fail to last position.
   3. Provide spring return normally closed actuators on chilled water valves.

2.5 DAMPER OPERATORS

A. General:

1. Provide actuators with torque capacity sized for minimum of 20 percent greater than maximum design stream velocity and hold tight seal against maximum system pressures.
2. Provide spring return for two position control and for fail safe operation.
3. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
4. Provide one operator for maximum 36 sq ft damper section.

B. Actuators shall be direct-coupled design requiring no crank arm or linkage for mounting to a shaft. Provide a means of overload protection at all angles of rotation that does not require the use of end switches. Provide with a NEMA rated enclosure appropriate for the installation. Actuator shall be sized for the torque required to seal damper at load conditions. Actuators shall be rated for the environment in which they will be installed. Proportional actuators shall be user configurable without the use of external computer software or programming tools. Calibration, input signal range selection, and control logic reversal shall be selectable with an external mode selection switch. Provide end switches where indicated on the sequence of operations.

C. Spring Return Actuators:

1. Coupling: toothed V-bolt clamp and nuts with toothed cradle.
2. Reversible Mounting: Provides either clockwise or counterclockwise operation.
3. Power Failure Operation: Mechanical spring return system drives load to the home position.
4. Motor Technology shall be either modulating or on/off based on the sequence of operations. Modulating types shall be microprocessor-controlled brushless DC motor. On/Off types shall be DC brush motor.

D. Non-Spring Return Actuators:

1. Couplings above 80 lb.-in. shall be toothed V-bolt clamp and nuts with toothed cradled. Couplings 80 lb.-in.and below shall be single cup-point set screw and toothed cradle.
2. Parallel Operation: Actuators shall be available that are capable of being mechanically or electrically paralleled.

E. Provide normally closed (spring return) actuators at Outside Air, Relief Air, and Exhaust Air damper locations unless otherwise indicated.

2.6 TEMPERATURE SENSORS

A. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.

B. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, two-wire 1000 ohm platinum RTD, or 20 kohn NTC.

C. Room temperature and duct temperature shall be ±.5 deg. F accuracy. All other temperature point types shall be ±.75 deg. F accuracy.

D. Room Temperature Sensors:

1. Room sensors shall be constructed for either surface or wall box mounting.
2. Room sensors in all public/transitory spaces including corridors, vestibules, receptions areas, restrooms, etc. shall be flat plate sensor only type with no local control/adjustment capabilites.
3. Room sensors in offices, classrooms, or other private/staff controlled spaces shall have an integral LCD display with the following capabilities:
   a. Display room air temperatures.
   b. Display and adjust room comfort set point.
   c. Timed override request push button with LED status for activation of after-hours operation.
   d. Display controller mode.
   e. Password selectable adjustment of set point and override modes.

2.7 HUMIDITY SENSORS

A. The sensor shall be a solid-state type, relative humidity sensor of the Thin Film Capacitance or Bulk Polymer Design. The sensor element shall resist service contamination.

B. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.

C. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.

D. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R (IP54) or NEMA 4 (IP65) enclosure with sealtite fittings.

E. A single point humidity calibrator shall be provided for field calibration. Transmitters shall be shipped factory pre-calibrated.

F. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.

2.8 OUTSIDE AIR SENSORS

A. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element. Temperature transmitters shall be of NEMA 3R (IP54) or NEMA 4 (IP65) construction and rated for ambient temperatures. The outdoor sensor can be easily mounted on a roof, pole or side of a building utilizing its already assembled mounting bracket. Outside Relative Humidity sensors 0-100% full range of accurate measurement; operating temperature -4 to 140F. Outside temperature sensors operating temperature range is -40 to 140F, +/- .55F.

2.9 DUCT MOUNT SENSORS

A. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

B. Provide an averaging sensor with multiple sensing points in ductwork greater in any dimension that 48 inches, where air temperature stratification exists, and in air handling unit cabinets. For plenum applications, such as mixed air temperature measurements, a continuous averaging sensor or a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment. Capillary supports at the sides of the duct shall be provided to support the sensing string.

2.10 PRESSURE SENSORS

A. Verify range of water pressure sensors such that full pumping head will not exceed maximum over-pressure limit.

B. Water pressure sensors shall be differential type with pressure sensing diaphragm housed in a stainless steel body. The body shall have two ¼ inch FNPT pressure connections. Pressure range shall be 0 to 25 or 0 to 50 psi based on the system requirements. The sensor shall allow a 200% of full scale over-pressure without damage or permanent offset. The output signal shall be 0-10 VDC or 4-20 mA and linear with applied pressure and shall have a field adjustable offset and span. Input power shall be 24 VAC or 24 VDC. Accuracy shall be +/- 0.25% of full scale range. Provide tee with valves and pressure gauge across switch for visual verification of differential.

C. Verify range of static pressure sensors. Velocity pressures of 1 inch w.c. corresponds to duct velocity 4000 fpm.

D. Air static pressure and velocity pressure sensors shall be differential type with pressure sensing diaphragm housed in a brass body. The body shall have two 3/16 inch barbed fittings suitable for connection by ¼ inch pneumatic tubing. Pressure range shall be 0 to 5 in. w.c. for static pressure sensing

and 0 to 1 inch w.c. for velocity pressure sensing. The sensor shall allow a 200% of full scale over-pressure without damage or permanent offset. The output signal shall be 0-10 VDC or 4-20 mA and linear with applied pressure and shall have a field adjustable offset and span. Input power shall be 24 VAC or 24 VDC. Accuracy shall be +/- 1% of full scale.

2.11 DIFFERENTIAL PRESSURE SENSORS

A. General Air and Water Pressure Transmitter Requirements:
   1. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
   2. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
   3. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
   4. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.

B. Low Differential Water Pressure Applications (0” - 20” w.c.)
   1. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications. Sensor shall maintain accuracy up to 20:1 ratio turn down with a reference accuracy of +0.2% of full span.

C. Medium to High Differential Water Pressure Applications (Up to 300 psi.)
   1. The differential pressure transmitter shall meet the low pressure transmitter specifications with the following exceptions. The sensor shall be capable of accurately measuring differential pressure up to 300 psi with a reference accuracy of +1% of full span.
   2. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.

D. Building Differential Air Pressure Applications (-1” to +1” w.c.)
   1. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications. Sensor shall maintain accuracy up to 20:1 ratio turn down with a reference accuracy of +0.2% of full span. Select the appropriate pressure range for each sensor in each application.

E. Differential Air Pressure Applications (0” to 5” w.c.)
   1. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications. Sensor shall maintain accuracy up to 20:1 ratio turn down with a reference accuracy of +0.25% or 0.5% of full span. Select the appropriate pressure range for each sensor in each application.

2.12 CARBON DIOXIDE (CO2) SENSORS

A. C02 sensors shall be provided with a jumper selectable output (0-20mA, 4-20mA, and 0-10VDC), relay output module, analog temperature module with linear 0-10VDC output for 32-122?F, and liquid crystal display.

B. The C02 sensors shall have the ability to monitor and output zone carbon dioxide. The C02 shall transmit the information back to the controller via jumper selectable 0-20mA, 4-20mA & 0-10VDC output signals. The C02 sensors shall be FCC compliant.

C. The C02 sensors shall have a response time (0-63%) of 1 minute or less. The CO2 output shall have a temperature dependence of less than 0.083% of full scale/?F. The long term CO2 stability shall be ±5%

of full scale for 5 years. CO2 measurement accuracy shall be ±40ppm + 2.0% of reading. CO2 non-linearity of less than 1.0% of full scale

2.13 REFRIGERANT LEAK DETECTORS

A. The refrigerant leak detector shall be a standalone device and shall provide a SPDT output to directly energize the refrigeration room exhaust ventilation fans. The detector shall include a sensor or sensors connected to a control panel. Two relay contacts at the control panel shall provide trouble and alarm indication to the Facility Management System. The alarm relay contact shall also directly energize the exhaust fans.

B. The refrigerant leak detector shall sense the type of refrigerant used in the specified chillers. Multiple sensors shall be required to detect different refrigerants and/or provide proper sensing coverage for the area of the refrigeration room.

2.14 STATUS AND SAFETY SWITCHES

A. General Requirements - Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

B. Current Sensing Switches - The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

C. Air Filter Status Switches - Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters. Provide appropriate scale range and differential adjustment for intended service.

D. Air Flow Switches - Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.

E. Air Pressure Safety Switches - Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

F. Low Temperature Limit Switches - The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

2.15 VARIABLE FREQUENCY DRIVE

A. Provide enclosed variable frequency drive suitable for operating the indicated loads. Where the load is less than 5 HP, provide a drive with capability of a future load of 5 HP. Conform to requirements of NEMA ICS 3.1. Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems. Conform to requirements of NFPA 70. Furnish products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

B. Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.

C. Product Data: Provide catalog sheets showing voltage, drive size, ratings and size of switching and over-current protective devices, short circuit ratings, dimensions, and enclosure details.

D. Test Reports: Indicate field test and inspection procedures and test results.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

F. Manufacturer's Field Reports: Include instructions for starting and operating drives, and describe operating limits that may result in hazardous or unsafe conditions. Indicate start-up inspection findings.

G. Maintenance Data: Include routine preventive maintenance schedule.

H. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

I. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

J. Furnish service and maintenance of drive for one year from Date of Substantial Completion.

K. Heat rejection from the drive shall be done through an external heat sink. Drives that pass air over the electronic components shall not be allowed.

L. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding. Prepare and start systems. Make final adjustments to installed drive to assure proper operation of the systems. Demonstrate operation of drives in automatic and manual modes.

M. Drive Design:

1. Rated Input Voltage shall be as described on the equipment schedule(s).
2. Operating Ambient: 32 degrees F to 104 degrees F. continuously.
3. Design for ability to operate drive with motor disconnected from output WITHOUT utilizing any interlock or safe.
4. Design to attempt five (adjustable) automatic restarts following fault condition before locking out and requiring manual restart.
5. Display: Provide integral digital display to indicate output voltage, output frequency, and output current.
6. Status Indicators: Separate indicators for over-current, over-voltage, ground fault, over-temperature, and input power ON.
7. Protection: AC Input Over-voltage, AC Input Under-voltage, Bus Over-voltage, Bus Under-voltage
8. Capable of setting three lockout frequencies minimum.
9. Volts per Hertz Adjustment: Plus or minus 10 percent.
10. Current Limit Adjustment: 60 - 110 percent of rated.
11. Acceleration Rate Adjustment: 0.5 - 30 seconds.
12. Deceleration Rate Adjustment: 1 - 30 seconds.
13. Provide HAND-OFF-AUTOMATIC selector switch and manual speed control.
14. Input Signal: Drive shall be capable of both 4-20 mA DC and 0-10 Volts DC-
15. Form C Output Contacts: Drive Fault and Drive Alarm.
16. One Form A programmable output.
17. One Form A Run contact.
18. Provide RS485 (contractor to verify) serial bus communications module compatible with building automation system. Provide all software, drivers, programming and documentation as required by building automation system.
19. Safety Interlocks: Provide terminals for remote contact to inhibit starting under both manual and automatic mode.
20. Control Interlocks: Provide terminals for remote contact to allow starting in automatic mode.
21. Disconnecting Means: Include integral fused disconnect switch on the line side of the drive.
22. Input Line Reactance: Provide a minimum of 5% impedance on the input to the drive. If the standard drive design does not meet the specification of 5%, additional inductors shall be provided to bring the drive up to the specified level.
23. Line reactors when required shall be furnished and installed by the drive manufacturer. Reactors shall be mounted in the enclosure where possible. If mounted exterior of enclosure, installation shall be provided by the drive supplier.
24. Enclosure: NEMA Standard 250, Type 1, 3R, 4, or 12 based on NEC requirements for the enclosure’s location.

25. Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

N. The drive shall be capable of providing the following features.
   1. 4 PID controllers for use of controlling the motor speed and up to 3 other functions.
   2. Contain a USB port for ease of programming, troubleshooting and trend logging through a standard laptop computer. The software for the communication shall be free and online.
   3. Automatic Motor Adaptation to provide tuning of the drive to the motor to optimize performance and efficiency.
   4. Automatic Energy Optimization adjusts the output voltage to match the real torque requirement to save energy.
   5. Drives serving cooling towers shall be provided with built in motor pre-heater to keep the motor warm and dry.
   6. Broken belt protection to fault the drive and signal the automation in loss of flow due to a broken belt or closed valve.
   7. Auto ramping eliminates tripping due to acceleration or deceleration.
   8. Flying start to match the motor speed of a spinning fan at time of start or restart.
   9. ENGLISH language display of all functions and faults the use of codes and numbers shall not be allowed.
   10. Quick setup menu to provide Easy and Quick start up and commissioning.
   11. Personal Menu for access by an operator to change only the items needed without hunting through the entire programming format.
   12. Keypad shall be password protected at two levels to prevent inadvertent changes by unauthorized personnel.
   13. STANDARD on board RFI/EMI filter.

O. Manufacturers shall be ABB, Allen Bradley, Danfoss, Square D, or Siemens.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that systems are ready to receive work.

C. Beginning of installation means installer accepts existing conditions.

D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.

E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

F. Ensure installation of components is complementary to installation of similar components.

G. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

H. Verify that surface is suitable for controller installation.

I. Do not install controller until building environment can be maintained within the service conditions required by the manufacturer.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Mount thermostats or temperaure sensors on interior walls.
   1. If thermostats or sensors must be mounted on exterior wall, provide insulated sub-base.

C. Mount freeze protection thermostats using flanges and element holders.

D. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.

E. Provide separable sockets for liquids and flanges for air bulb elements.

F. Provide valves with position indicators and with pilot positioners where sequenced with other controls.

G. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.

H. Mount control panels adjacent to associated equipment on vibration free walls or free-standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

I. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.

J. Identify variable frequency controllers in accordance with Section 26 0553.

K. Install hazardous gas monitoring equipment including sensors, audible alarms, as shown on Contract Drawings, and as recommended by manufacturer of equipment, and as required by authorities having jurisdiction. Install conduit and wiring from sensors to control panel and to the fan starters/ HVAC control panel as recommended by manufacturer of equipment.

3.3 FIELD QUALITY CONTROL

A. Provide the service of the manufacturer's field representative to prepare and start VFD controllers.

B. Perform field inspection and testing in accordance with Section 01 4000.

C. Inspect and test in accordance with NETA STD ATS, except Section 4.

D. Perform inspections and tests listed in NETA STD ATS, Section 7.17.

3.4 CLOSEOUT ACTIVITIES

A. Demonstrate operation of VFD controllers in automatic and manual modes.

3.5 MAINTENANCE

A. Provide service and maintenance of control system for one year from Date of Substantial Completion.

B. Provide complete service of controls systems, including call backs, and submit written report of each service call.

C. In addition to normal service calls, make minimum of seasonal complete normal inspections of approximately four hours duration to inspect, calibrate, and adjust controls.

SECTION 23 09 23 - DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

A. System description.
B. Operator interface.
C. Web browser interface.
D. Controllers.
E. Power supplies and line filtering.
F. BACNET capabilities.
G. System software.

1.2 REFERENCE STANDARDS

A. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2024, with Errata (2025).
B. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests; 2019h, with Editorial Revision (2022).
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
D. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.3 ADMINISTRATIVE REQUIREMENTS

A. The Automatic Temperature Controls Contractor shall coordinate with the project Balancing Contractor & Chemical Treatment Contractor for control software access necessary to facilitate the balancing & flushing processes. The Automatic Temperature Controls Contractor shall allow full building system software access to the project balancing contractor during construction and project commissioning as necessary. The Automatic Temperature Controls Contractor shall provide an override button available to the Balancing and Chemical Treatment Contractor that will drive open all control valves for the purpose of flushing & balancing the hydronic system(s). All water coils shall be opened to the system prior to the air system start-up to ensure proper mixing of gylcol throughout the piping system. The Automatic Temperature Controls Contractor shall provide up to 12 hours of assistance for navigation and use of software as required.

1.4 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
    1. Product Data and Shop Drawings: Contractor shall provide shop drawings or other submittals on all hardware, software, and installation to be provided. No work may begin on any segment of this project until submittals have been reviewed and approved for conformity with the design intent. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Submittals shall include:
    2. Direct Digital Control System Hardware:
        a. A complete bill of materials of equipment to be used shall be listed indicating quantity, manufacturer, model number, and other relevant technical data.

b. Manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions shall be included for all relevant items including but not limited to: direct digital controller and all controller panels; transducers/transmitters; sensors including accuracy data; actuators; valves; relays/switches; control panels; power supply; batteries; operator workstation equipment; wiring; wiring diagrams and layouts for each control panel; Schematic diagrams for all field sensors and controllers with floor plans of all sensor locations and control hardware.

3. Central System Hardware and Software
   a. A complete bill of material of equipment used indicating quantity, manufacturer, model number, and other relevant technical data.

   b. Manufacturer's description and technical data, such as product specification sheets and installation/maintenance instructions shall be included for all relevant items including but not limited to: central processing unit (CPU); monitors; keyboard; uninterruptible power supply; interface equipment between CPU and control panels; operating system software; operator workstation software; color graphic software; and third-party software.

   c. A schematic diagram for all control wiring, communication wiring and power wiring shall be provided. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers, function and data link protocol(s). Show all interface wiring to the control system.

   d. Provide detailed riser diagrams of wiring between central control unit, operator workstation(s), routers, gateways and all control panels.

   e. A list of the color graphic screens shall be provided. For each screen, provide a conceptual layout of pictures and data, and show or explain which other screens can be directly accessed.

4. Controlled Systems:
   a. A schematic diagram of each controlled system. The schematics shall have all control points/objects labeled and with point/object names shown or listed. The schematics shall graphically show the location of all control elements in the system.

   b. A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, it shall be labeled with the same name. All terminals shall be labeled

   c. An instrumentation list for each controlled system. Each element of the controlled system shall be listed in table format. The table shall show element name, type of device, manufacturer, model number, and product data sheet number.

   d. A mounting, wiring, and routing plan view drawing. The drawing shall be done in ¼" scale. The design shall take into account HVAC, electrical and other systems' design and elevation requirements. The drawing shall show the specific location of all concrete pads and bases and any special wall bracing for panels to accommodate this work

   e. A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.

f. A point/object list for each system controller including inputs and outputs (I/O), point/object number, the controlled device associated with the I/O point/object, and the location of the I/O device. Software flag points/objects, alarm points/objects, etc.

C. Closeout Documents:

1.5 QUALITY ASSURANCE

A. Perform work in accordance with NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.

C. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience.

D. Direct digital control panels shall comply with Federal Communications Commission (FCC) Regulation, Part 15, Subpart J, for Class A computing devices.

E. All wiring shall be in accordance with the current National Electrical Code and all local electrical codes.

F. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.

PART 2 PRODUCTS

2.1 Manufacturers

A. Trane

2.2 **SYSTEM DESCRIPTION**

A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.

B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.

C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 13.

E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.

F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.3 OPERATOR INTERFACE

A. Furnish a PC-based workstation. The workstation shall reside on the same Ethernet protocol network as the Building Controllers. The workstation information access shall use the BACnet protocol.

B. Provide a Windows PC-based laptop for use by the owner for access to DDC controls. The computer shall be new and current with today's standards (i.e. memory capacity, proccessing speed, etc.) and with enough hard drive capacity for 10 years of trending data. A two-button mouse also will be provided. Furnish all required serial (USB), and network communication ports, and all cables for proper system operation. The PC shall have aminimum 13-inch screen for laptops. Coordinate computer requirements with owner prior to purchasing.

C. Furnish a concurrent multi-tasking operating system that is coordinated with the owner to comply with their network requirements. The operating system also shall support the use of other common software

applications that operate under Microsoft Windows. Examples include Microsoft Excel, Microsoft Word, and Microsoft Access.

D. The operator workstation software shall be a graphical user interface (GUI). The system shall allow display of up to 10 dynamic and animated graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while on-line. An operator with the proper password level shall be able to add, delete, or change dynamic objects on a graphic. Dynamic objects shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the object.

E. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics. The graphics generation package also shall provide the capability of capturing or converting graphics from other programs such as Visio or AutoCAD.

F. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program. Graphics shall be created by drag-and-drop selection of graphic symbols and drag-and-link with BACnet objects with dynamic and interactive display fields.

G. Each workstation shall provide operator interface and off line storage of system information. Provide the following applications at each workstation:

1. Each workstation shall store on the hard disk a copy of the current database of each Building Controller. This database shall be updated whenever an operator initiates a save command. A system operator with the proper password clearance shall be able to save the database from any system panel. The operator shall be able to clear a panel database via the network and may initiate a download of a specified database to any panel in the system from the network.
2. The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the functions accessible to viewing and/or changing each system application.
3. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, alarm limit differentials, states, and reactions for each object in the system. Alarm messages shall alert the operator in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying upon acronyms or other mnemonics. The operator shall be able to determine (by object) what, if any, actions are to be taken during an alarm.
4. The operator shall be able to define a custom trend log for any data object in the system. Trend data shall be sampled and stored on the Building Controller panel, and be archived on the hard disk for use in spreadsheets and standard database programs. The operator shall be able to view all system alarms and change of states from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms.
5. Provide a method for the operator to view, and edit if applicable, the status of any object and property in the system. The status shall be available by menu, on graphics, or through custom programs.

H. Each PC workstation shall support editing of all system applications. Provide editors for each application at the PC workstation. The applications shall be downloaded and executed at one or more of the controller panels.

1. Provide an editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and set points for all controllers.

2. An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and month. This shall consist of a monthly calendar for each schedule. Exception schedules and holidays shall be shown clearly on the calendar. Provide a method for allowing several related objects to follow a schedule. The start and stop times for each object shall be adjustable from this master schedule.
3. Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded.

2.4 WEB BROWSER INTERFACE

A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the BAS, shall not be acceptable. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

B. The Web browser client shall support user log-on identification and password. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

C. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format. Storage of the graphical screens shall be in the Server, without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client PC are not acceptable.

D. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.

E. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to modify common application objects, such as schedules, calendars, and set points in a graphical manner. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

F. No entry of text shall be required for Commands to start and stop binary objects.

G. The system shall provide the capability to specify a user’s (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

H. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.5 CONTROLLERS

A. SUPERVISORY NETWORK CONTROLLERS:

1. Supervisory network controllers shall be used to manage and schedule global control strategies on the network and communicate with the local Operator’s Workstation. A minimum of one (1) supervisory network controller shall be used for the direct digital control system. Each supervisory network controller shall include its own microprocessor, program and data memory, power supply, network communications module, and battery. Supervisory network controllers may also include input/output modules and shall be capable of sharing its point and data information with other controllers on the network.

B. EQUIPMENT CONTROLLERS:

1. Equipment controllers shall be used to control all large HVAC equipment such as air handling units, central heating plant equipment, central cooling plant equipment, etc. A minimum of one (1) equipment controller shall be used for each air handling unit.
2. Each equipment controller shall include its own microprocessor, program and data memory, power supply, input/output modules, and battery. All program and data memory shall be read/write random access memory (RAM) type with battery backup. The battery shall be self-charging and capable of supporting all memory within the controller for a minimum of seventy-two (72) hours if commercial power to the unit is interrupted. Upon the resumption of normal power, the runtime control software shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.
3. Each equipment controller shall be capable of sharing point and data information with other controllers, such that control sequences or control loops executing in one controller may receive input signals from sensors connected to other controllers on the network. If the network communication link fails or the originating controller malfunctions, the control loop shall continue to function using the last value received from the failed controller. Failure of one controller shall have no other effect upon any of the other controllers in the network.
4. This contractor shall provide a NEMA 1 enclosure for any controllers furnished.
5. Terminal unit controllers shall be used to control all small HVAC terminal unit equipment such as variable air volume boxes, dual duct boxes, heat pumps, fan coil units, unit ventilators, terminal coils, etc. A minimum of one (1) terminal unit controller shall be used for each terminal unit.

C. TERMINAL UNIT CONTROLLERS:

1. Terminal unit controllers shall be used to control all small HVAC terminal unit equipment such as variable air volume boxes, dual duct boxes, heat pumps, fan coil units, unit ventilators, terminal coils, etc. A minimum of one (1) terminal unit controller shall be used for each terminal unit.
2. This contractor shall provide a NEMA 1 enclosure for any controllers furnished.
3. Each terminal unit controller shall include its own microprocessor, program and data memory, power supply, input/output modules, and battery. All program and data memory shall be read/write random access memory (RAM) type with non-volatile memory similar to EEPROM (Electrically Erasable Programmable Read-Only memory). Upon the resumption of normal power, the runtime control software shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.
4. Each terminal unit controller shall be capable of sharing point and data information with other controllers, such that control sequences or control loops executing in one controller may receive input signals from sensors connected to other controllers on the network. If the network communication link fails or the originating controller malfunctions, the control loop shall continue to function using the last value received from the failed controller. Failure of one controller shall have no other effect upon any of the other controllers in the network.

2.6 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies:

1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
2. Limit connected loads to 80 percent of rated capacity.
3. Match DC power supply to current output and voltage requirements.
4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
7. Operational Ambient Conditions: 32 to 120 degrees F.
8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD-810 for shock and vibration.
9. Line voltage units UL recognized and CSA approved.

B. Power Line Filtering:

1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
2. Minimum surge protection attributes:
   a. Dielectric strength of 1000 volts minimum.
   b. Response time of 10 nanoseconds or less.
   c. Transverse mode noise attenuation of 65 dB or greater.
   d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.7 BACNET CAPABILITIES

A. BACnet Interoperability Building Blocks (BIBBS) for each DDC system component (network or system level controller) proposed. BACnet is not required for unitary or equipment controllers.

B. Communication shall be through a translator/gateway that maintains the BACnet protocol.

C. The unitary or equipment controller supplier shall provide a list confirming their support for all mandatory data, and identifying which optional network variables and configuration properties they support.

D. Certification shall be verified through the BIBBS statement for the BACnet Certification Authority.

E. BACnet shall communicate over an Ethernet connection at the system level and conform to ASHRAE Std 135.

F. Contractor shall map all available Bacnet points for each applicable piece of equipment at discretion of project engineer and owner.

2.8 SYSTEM SOFTWARE

A. All necessary runtime control software to form a complete operating system as described in this specification shall be provided. The software programs specified in this section shall be provided as an integral part of the direct digital controllers and shall not be dependent upon any higher level computer for execution.

B. The runtime control software in the equipment controllers and terminal unit controllers shall have the ability to perform the following pre-tested control algorithms and control functions:

1. Control Loops (two-position, proportional, PI, PID)
2. Outdoor Air Reset Control
3. Minimum On/Off Times
4. Random Start Delay
5. Night Setback/Setup Control
6. Simultaneous Heating/Cooling Lockout
7. Point History Collection
8. Alarm Reporting
9. Change of Value Reporting

C. Point History Collection shall provide a record of value of analog I/O points over the last 72 hours, at 30-minute intervals, and a record of the last 50 status changes for binary type points with the capability of archiving data after that.

D. Runtime control software in the supervisory network controllers shall have the ability to perform any or all of the following system and energy management routines:

1. Time of Day, Calendar Based, and Holiday Scheduling
2. Trending
3. Optimum Start and Stop
4. Peak Demand Limiting
5. Chiller Plant Optimization

E. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Sequence of Operation.

F. Custom Process Programming Capability: Runtime control software shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.2 INSTALLATION

A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93.

C. Provide required line voltge wiring including breakers, conductors, conduit, transfromers, disconnects and all required accessories to support control systems.

D. Provide conduit and electrical wiring in accordance with Division 26. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

E. Controllers shall be mounted in NEMA 1 enclosures near the equipment served. If multiple controllers are installed in a single enclosure, the controller shall be noted as to the location and equipment served along with a tag on the controlled equipment as to the location of the controller if not within the same room.

F. VFD's shall be mounted by this contractor. Line voltage to and from the VFD will be by others. Locate VFD's with disconnects in location as shown on plan or within visual sight of the motor in which the VFD serves.

G. Install software in direct digital control panels and Operator's Workstation. Implement all features of programs to specified requirements and appropriate to sequence of operation.

H. Connect and configure equipment and software to achieve the sequence of operation specified.

I. Verify location of room sensors, thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Locate 48 inches above floor.

J. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

K. Install damper motors on outside of duct in warm areas, not where exposed to outdoor temperatures.

L. Install labels and nameplates to identify control components including the following:

1. Control cabinet nameplates
2. Control valve tags
3. Control damper labels
4. Sensor tags

3.3 **CONNECTION TO OWNER'S DATA SYSTEM**

A. This contractor shall be responsible for the installation of all data wiring, conduit, terminations, etc., to connect the temperature controls system into the owner's data network. This contractor shall coordinate the location of the data system connection point, network protocols, and network address with the owner's IT personnel before starting work.

B. If multiple data connections are required (i.e., multiple ATC panel locations), the ATC contractor shall be responsible for each of the connections necessary.

C. All costs associated with the installation of the required data connections shall be borne by this contractor.

3.4 BACNET CONNECTIONS TO OTHER EQUIPMENT

A. This contractor shall coordinate the BACnet protocol and all wiring between the temperature control system and furnished equipment manufacturer.

B. This contractor shall coordinate the connection protocol (MS/TP of IP) with the equipment manufacturer and/or supplier.

C. This contractor shall be responsible for the installation of all data wiring, conduit, terminations, etc., to connect the temperature controls system into equipment control panel. This contractor shall coordinate the location of the data system connection point, network protocols, and network address before starting work.

D. All costs associated with the installation of the required data connections shall be borne by this contractor.

3.5 ELECTRICAL WIRING AND CONNECTIONS

A. Installation of raceways, boxes, cabinets, wire and cable shall meet or exceed NEC, latest edition.

B. All cabling in mechanical rooms, down walls to thermostat boxes, and any exposed areas (i.e. gymnasiums, auditoriums, etc) shall be housed in conduit. Areas above concealed ceiling spaces without conduit on the cabling shall have wiring supported from structure above, Wire will not be allowed to lay free on the ceiling/space.

C. Provide electrical conduit seals to close off openings into the electrical boxes behind any thermostat or sensor. This shall include sealing the conduit after wiring installation. Contractor shall evaluate each box location and insulate the inside of the box if necessary.

D. All conduit installed as part of the temperature controls system shall be Blue in color.

E. Control wiring when installed above the ceiling shall be furnished with a plenum rated jacket. Wiring may be placed in cable tray where available.

F. Fasten flexible conductors, bridging cabinets and doors, neatly along hinge side; protect against abrasion. Tie and support conductors neatly.

G. Number-code or color-code conductors except local individual room controls, for future identification and servicing of control system.

H. Connect electrical components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

I. Connect manual reset limit controls independent of manual control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

J. Connect HAND-OFF-AUTO selector switches to override automatic interlock controls when switch is in HAND position.

3.6 MANUFACTURER'S FIELD SERVICES

A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

3.7 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate complete and operating system to Owner.

B. Manufacturer's Field Services: Provide the services of a factory-authorized service representative to demonstrate and train Owner's maintenance personnel as specified below.

C. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.

D. Provide operator training on data display, alarm and status descriptors, requesting data, execution of commands, and request of logs. Schedule training with Owner with at least 7 days' notice.

3.8 MAINTENANCE

A. Provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion.

B. Provide two complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.

C. Provide complete service of systems, including call backs. Make minimum of four complete normal inspections of approximately two hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

3.9 COMMISSIONING

A. Manufacturer's Field Services: Provide the services of a factory-authorized service representative to start control systems.

B. Test and adjust controls and safeties. Recalibrate all sensors where wiring lengths effect sensor readings.

C. Replace damaged or malfunctioning controls and equipment.

D. Start, test, and adjust control systems.

E. Demonstrate compliance with requirements.

F. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

END OF SECTION

SECTION 23 11 23 - FACILITY NATURAL-GAS PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pipe, pipe fittings, valves, and connections for natural gas piping systems.
B. Labratory Safety Device System

1.2 REFERENCE STANDARDS

A. ANSI Z21.18/CSA 6.3 - Gas Appliance Pressure Regulators; 2019.
B. ANSI Z21.80/CSA 6.22 - Line Pressure Regulators; 2019.
C. ASME B1.20.1 - Pipe Threads, General Purpose, Inch; 2013 (Reaffirmed 2018).
D. ASME B16.24 - Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500; 2021.
E. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard; 2025.
F. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2025, with Errata.
G. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
H. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes; 2024.
I. ASME B31.1 - Power Piping; 2024.
J. ASME B31.9 - Building Services Piping; 2020.
K. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.
L. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2025.
M. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2020.
N. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
O. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2018, with Editorial Revision (2020).
P. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).
Q. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; 2012.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
   2. Welders' Certificates: Submit certification of welders' compliance with ASME BPVC-IX.
C. Closeout Documents:
   1. Project Record Documents: Record actual locations of valves.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.
B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.

D. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

E. Identify pipe with marking including size, ASTM material classification, and ASTM specification.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.6 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.1 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Grade B, Type F, Schedule 40 black.
   1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
   2. Joints: Threaded or welded to ASME B31.1.

B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A) or L (B) annealed.
   1. Fittings: ASME B16.26, cast bronze.
   2. Joints: Flared.

C. Press fit couplings and fittings may be used in lieu of unions, flanges, or threaded connections for gas piping systems. MegaPress fit system shall be as manufactured by Viega, Nibco, or Rigid Tool Co. Carbon steel press fittings shall conform to the material and sizing requirements of ASME B16.3 or ASTM A420. O-rings for carbon steel press fittings used on gas systems shall be HNBR. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer. Press fit installation shall be in accordance with the manufacturer's specifications contained in latest published literature. All press fit couplings, fittings and specialties shall be the products of a single manufacturer. Ball valves shall be lead free. Valves shall be as manufactured by Viega, Milwaukee, Apollo, Nibco, or an approved equal.

2.2 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches and Under:
   1. Ferrous Pipe: Class 150 malleable iron threaded unions.

B. Flanges for Pipe Size Over 1 Inch:
   1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.

2.3 PIPE HANGERS AND SUPPORTS

A. Hanger Manufacturers:
   1. Anvil
   2. Erico-Caddy

B. Hangers and strut located in corrosive areas shall be type 316 stainless steel with stainless steel hardware.

C. All exterior hangers shall be hot dip galvanized or stainless steel. Zinc plated hardware is not acceptable for outdoor use.

D. Provide hangers and supports that comply with MSS SP-58 and MSS SP-69.

1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 or MSS SP-69 recommendations, which ever is more stringent.
2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
3. Trapeze Hangers: Welded steel channel frames attached to structure.
4. Vertical Pipe Support: Steel riser clamp.
5. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.

E. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:

1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.

2.4 BALL VALVES

A. Manufacturers:

1. Conbraco Industries, Inc: www.apollovalves.com.
2. Milwaukee Valve Company: www.milwaukeevalve.com.
3. Nibco, Inc: www.nibco.com.

B. Construction: MSS SP-110, Class 150, 400 psi CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, full port, Teflon seats and stuffing box ring, blow-out proof stem, lever handle, solder, threaded, or weld ends.

1. Provide a valve on the gas supply to each piece of equipment requiring gas.

C. Provide electric solenoid fuel shut-off valve on gas line to kitchen ranges. Solenoid shall be suitable for 120 volts A.C.

2.5 Natural gas PRESSURE REGULATORS

A. Description: Single stage and suitable for fuel gas service. Include steel jacket and corrosion-resistant components, elevation compensator, and atmospheric vent.

1. 2” and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
2. 2-1/2” and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
3. Service Pressure Regulators: ANSI Z21.80/CSA 6.22. Include 100-psig minimum inlet pressure rating.
4. Line Pressure Regulators: ANSI Z21.80/CSA 6.22 with 10-psig inlet pressure rating, unless otherwise indicated.
5. Appliance Pressure Regulators: ANSI Z21.18/CSA 6.3. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

B. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

C. Provide pressure regulators for all equipment, unless provided by manufacturer, to reduce gas pressure from line psig to pressure required at equipment.

2.6 LABORATORY SAFETY DEVICE SYSTEM: (Natural Gas)

A. Provide a laboratory safety device system for each Science Room as shown on the Drawings. Each system shall include, but not be limited to, a utility controller panel, solenoid valves, remote emergency shut off button, gas detector and all interconnections. The system shall and be UL listed and labelled.

B. Provide a Utility Controller with panel mounted switches to activate remote solenoids and relays to control natural gas. Controller shall utilize a pressure transducer to perform a pressure drop test on the natural gas line before allowing gas to be supplied. Controller shall continuously check incoming gas supply pressure throughout operation. Controller shall provide line voltage signals for output circuits. Controller shall provide inputs for remote EPO’s and Gas Sensors. The Controller shall be equipped with an Authority Key Lock that restricts activation of output signals to the instructor or educator. Controller shall be provided with a mounted EPO button. Output signals will require Key Lock authority for re-set.

C. Each Controller shall be provided with a UL approved pressure transducer to be installed on the natural gas pipe, either via the solenoid valve or via a reducing fitting located as close to the solenoid valve as is permissible on the downstream side.

D. Provide UL approved solenoids for Gas services. All solenoids shall be normally closed and fail closed on loss of power. Number of solenoids, intended use and pipe sizes are as noted on the Drawings.

E. Furnish and install a NG (Methane) Gas Sensor to detect natural gas within the classroom. Detector to provide clear digital traffic light reading of %LEL value. Detector shall provide a local visual and audible alarm. Integrate Fuel Gas Sensor with low voltage input on Controller. Sensor quantity and location shall be as per manufacturer's instructions. Verify type of gas used with manufacturer for gas specific requirements (i.e. natural gas, propane).

F. Install system in accordance with manufacturer's recommendations and instructions. Verify that all components and devices comply with manufacturer's requirements and recommendations and that all devices and installations conform to Drawings and specification requirements.

G. Provide a manufacturer's parts warranty covering 3 Years from date of completion.

H. Acceptable manufacturers shall be American Gas Safety (Merlin), or an approved equal.

2.7 lag gas turrets (gt-1)

A. Manufacturers:
   1. T&S Brass
   2. Chicago Faucets

B. Construction:
   1. Polished chrome plated body with 3/8" NPT female inlet.
   2. Ball valve with hose cock that accepts 1/4" to 3/8" I.D. hose.
   3. Dark blue press-in index for natural gas.
   4. Material: Polished chrome plated brass panelflange and ball valve hose cock.
   5. Gas turret to be similar to T&S Brass BL-4250-01.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

C. Install piping to maintain headroom, conserve space, and not interfere with use of space.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.

F. Provide access where valves and fittings are not exposed.

G. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

H. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.

1. All exposed gas piping outdoors shall be cleaned of all dirt, grease and oil, painted with one coat primer and two coats enamel of a color to be selected by the architect. If steel piping is used, a second option shall be galvanized in lieu of painting.

I. Install valves with stems upright or horizontal, not inverted.

J. Pressure regulators that require a vent shall have an independent vent to the outside of the building. The vent shall be designed to prevent the entry of water or foreign objects. Regulator vents shall terminate at least 3 feet from doors, operable windows, nonmechanical intake openings, and openings into direct-vent appliances. The vent termination shall be located at least 12 inches above grade and shall be suitably screened and hooded to prevent accidental closure of the vent pipe.

1. A vent to the outside of the building is not required for regulators equipped with and labeled for utilization with approved vent-limiting device installed in accordance with the manufacturer's instructions. A regulator and vent limiting means combination listed as complying with ANSI Z21.80/CSA 6.22, Line Pressure Regulators, shall not be required to be vented to the outdoors. A listed gas appliance regulator factory equipped with a vent limiting device is not required to be vented to the outdoors.

K. Piping greater than 2 inch shall be welded.

L. Gas piping installed in plenums.

1. Steel gas piping in plenums shall be welded.
2. In lieu of steel, If copper is allowed by AHJ, brazed joints are allowed.

M. Pipe Hangers and Supports:

1. Install in accordance with ASME B31.9.
2. Support horizontal piping as indicated.
3. Place hangers within 12 inches of each horizontal elbow.
4. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
6. Provide copper plated hangers and supports for copper piping.
7. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
   a. Painting of interior piping systems and components is specified in Section 09 91 23.
   b. Painting of exterior piping systems and components is specified in Section 09 91 13.
8. Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 23 05 48.

3.4 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

3.5 SERVICE CONNECTIONS

A. Provide new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure of 11 inch wg. Provide regulators on each line serving appliances, sized in accordance with equipment.

3.6 SCHEDULES

A. Pipe Hanger Spacing shall comply with all local applicable codes.

END OF SECTION

SECTION 23 21 13 - HYDRONIC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Hydronic system requirements.
B. Heating water piping, above grade.
C. Equipment drains and overflows.
D. Pipe hangers and supports.
E. Unions, flanges, mechanical couplings, and dielectric connections.

1.2 REFERENCE STANDARDS

A. 24 CFR 51 - Department of Housing and Urban Development Environmental Criteria and Standards; current edition.
B. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2025, with Errata.
C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
F. ASME B16.51 - Copper and Copper Alloy Press-Connect Pressure Fittings; 2021.
G. ASME B31.9 - Building Services Piping; 2020.
H. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.
I. ASTM A183 - Standard Specification for Carbon Steel Track Bolts and Nuts; 2014 (Reapproved 2020).
J. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2025.
K. ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
L. ASTM B32 - Standard Specification for Solder Metal; 2020.
M. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2020.
N. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
O. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
P. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications; 2018, with Editorial Revision (2024).
Q. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2025a.
R. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2024.
S. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80; 2020.
T. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020 (Reapproved 2024).
U. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 2024.
V. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2024).
W. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.

X. AWS D10.12M/D10.12 - Guide for Welding Mild Steel Pipe; 2000.

Y. AWWA C606 - Grooved and Shouldered Joints; 2022.

Z. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

AA. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; 2012.

1.3 SUBMITTALS

A. See Devision 01 - Administrative Requirements, for submittal procedures.

B. Shop Drawings:

1. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.

C. Product Data:

1. Include data on pipe materials, pipe fittings, valves, and accessories.
2. Provide manufacturers catalog information.
3. Indicate valve data and ratings.
4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.

D. Closeout Documents:

1. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
2. Project Record Documents: Record actual locations of valves.
3. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum five years of experience.

C. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.

D. Coupling Manufacturer:

1. Perform on-site training by factory-trained representative to the Contractor's field personnel in the proper use of grooving tools and installation of grooved joint products.
2. Periodic job site visits by factory-trained representative to ensure best practices in grooved joint installation.

E. Welder Qualifications: Certify in accordance with ASME BPVC-IX.

1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.6 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.1 HYDRONIC SYSTEM REQUIREMENTS

A. Comply with ASME B31.9 and applicable federal, state, and local regulations.

B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:

1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
2. Grooved mechanical joints may be used in indoor, accessible locations only.
   a. Accessible locations include those exposed on interior of building, above lay-in-tile ceilings, in mechanical rooms, and as approved by Engineer.
   b. Grooved mechanical connections and joints comply with AWWA C606.
      1) Ductile Iron: Comply with ASTM A536, Grade 65-45-12.
   c. Use rigid joints unless otherwise indicated.
   d. Depending on pipe size, three or four flexible joints may be used in lieu of a flexible connector. Consult with coupling manufacturer's installation instructions.
   e. Use gaskets of molded synthetic rubber with central cavity, pressure responsive configuration and complying with ASTM D2000, Grade 2CA615A15B44F17Z for circulating medium up to maximum 230 degrees F or Grade M3BA610A15B44Z for circulating medium up to maximum 200 degrees F.
   f. Provide steel coupling nuts and bolts complying with ASTM A183.
   g. Provide rigid couplings with shift limiting slant pad.
3. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.

C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.

1. Where grooved joints are used in piping, provide grooved valve/equipment connections if available; if not available, provide flanged ends and grooved flange adapters.

D. Valves: Provide valves where indicated:

1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch ball valves with cap; pipe to nearest floor drain.
2. For throttling, bypass, or manual flow control services, use ball or butterfly valves.
3. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.

E. Welding Materials and Procedures: Comply with ASME BPVC-IX.

2.2 HEATING WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:

1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D10.12M/D10.12 welded.
2. Threaded Joints: ASME B16.3, malleable iron fittings.
3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings with shift limiting slant pad.
4. Carbon steel press fittings shall conform to the material and sizing requirements of ASME B16.3 or ASTM A420. O-rings for carbon steel press fittings shall be EPDM. All O-rings shall be rated for

50% ethylene or propylene glycol with 210 degree water. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

a. Press fit installation shall be in accordance with the manufacturer's specifications contained in latest published literature.

b. All press fit couplings, fittings and specialties shall be the products of a single manufacturer.

c. Manufacturers:

1) Viega

2) Milwaukee

3) Apollo

4) Nibco

B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:

1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
   a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

   b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.

2. Grooved Joints: AWWA C606 grooved tube, fittings of same material, and copper-tube-dimension mechanical couplings.
3. Copper press fittings shall be double pressed type and conform to the material and sizing requirements of ASME B16.51. O-rings for copper press fittings shall be EPDM.
   a. All O-rings shall be rated for 50% ethylene or propylene glycol with 210 degree water.

   b. Press fit installation shall be in accordance with the manufacturer's specifications contained in latest published literature.

   c. All press fit couplings, fittings and specialties shall be the products of a single manufacturer.

   d. Manufacturers:

      1) Viega

      2) Milwaukee

      3) Apollo

      4) Nibco

4. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
5. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.51, utilizing EPDM, nontoxic synthetic rubber sealing elements.
   a. Manufacturers:

      1) Apollo Valves: www.apollovalves.com/#sle.

2) Grinnell Products: www.grinnell.com/#sle.

3) Substitutions: See Section 01 60 00 - Product Requirements.

2.3 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tube (AHU condensate piping): ASTM B88 (ASTM B88M), Type M, drawn; using one of the following joint types:
1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
2. Copper press fittings shall be double pressed type and conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. O-rings for copper press fittings shall be EPDM.
a. All O-rings shall be rated for 50% ethylene or propylene glycol with 210 degree water.

b. Press fit installation shall be in accordance with the manufacturer's specifications contained in latest published literature.

c. All press fit couplings, fittings and specialties shall be the products of a single manufacturer.

d. Manufacturers:

1) Viega

2) Milwaukee

3) Apollo

4) Nibco

B. PVC Pipe (boiler condensate piping): ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.
1. Fittings: ASTM D2466 or D2467, PVC.
2. Joints: Solvent welded in accordance with ASTM D2855.

2.4 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58 and MSS SP-69.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 or MSS SP-69 recommendations, which ever is more stringent.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
9. Wall Support for Pipe Sizes 4 Inches and Greater: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 Inches and Greater: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

13. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 Inches and Greater: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated for unisulated copper pipe.
16. Hanger Rods: Zinc-plated steel, threaded both ends, threaded one end, or continuous threaded.
17. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
18. Hangers and strut located in corrosive areas shall be type 316 stainless steel with stainless steel hardware.
19. Hangers for all piping shall be oversized to encircle the piping and the insulation, the insulation shall be continuous through all hangers.

B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

C. Roof Pipe Supports:

1. Compact pipe support: Other than chilled and condenser water, shall be supported by a polyethylene, or vulcanized recycled rubber block with an integral strut channel for clamps and/or support accessories. Water piping, natural gas piping, etc. shall be placed at the same elevation where running parallel. Pipe supports shall be installed according to manufacturer's recommendations. Pipe supports shall be spaced as indicated in following section. Supports shall be installed to allow for expansion and contraction and shall not be adhered to roof surface.
2. Pipe stands: Chilled and condenser water pipes shall be supported from stands supported from the roof by vulcanized recycled rubber blocks with an integral strut channel. Pipe stands supported by the roof blocks shall be constructed of a minimum 12 ga. Channel with connectors consisting of ½" bolts, ½" washers & ½" nuts. Hangers suspended from pipe stands shall be as specified in the previous section. Supports shall be installed to allow for expansion and contraction and shall not adhere to the roof surface.
3. All hanger hardware located outdoors shall be hot dip galvanized after fabrication in accordance with ASTM A123. All hanger hardware shall be hot dip galvanized or stainless steel. Zinc plated hardware is not acceptable for outdoor use.
4. Place a hanger/support within 12 inches of each horizontal elbow.
5. Manufacturers:
   a. Erico
   b. Advanced Support Products

2.5 UNIONS, FLANGES, and MECHANICAL COUPLINGS

A. Unions for Pipe of 2 Inches and Less:

1. Ferrous Piping: 150 psi brass or malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe 2 Inches and Greater:

1. Ferrous Piping: 150 psig forged steel, slip-on.
2. Copper Piping: Bronze.
3. Gaskets: 1/16 inch thick, preformed neoprene.

C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket. Privide with shift limiting slant pad on mechanical coupling.

1. Dimensions and Testing: In accordance with AWWA C606.
2. Mechanical Couplings: Comply with ASTM F1476.
3. Housing Material: Ductile iron complying with ASTM A536.
4. Coupling gasket shall be EPDM molded synthetic rubber, per ASTM D-2000 suitable for temperature range from minus 30 degrees F to 250 degrees F.

5. Coupling bolts shall be track head type with hexagonal heavy nuts, per ASTM A-449 and A-183-60.
6. When pipe is field grooved, provide coupling manufacturer's grooving tools.
7. Manufacturers:
   a. Victaulic Company: www.victaulic.com.

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
C. Remove scale and dirt on inside and outside before assembly.
D. Prepare piping connections to equipment using jointing system specified.
E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
F. After completion, fill, clean, and treat systems. See Section 23 25 00 for additional requirements.

3.2 INSTALLATION

A. Welding of piping:
   1. The Contractor shall be responsible for welding quality and shall conduct tests of the welding procedures used in the work, determine the suitability of the procedures used, determine that the welds made will meet the required tests, and determine that the welding operators have the ability to make sound welds under standard conditions. All welding shall comply with ASME B31.9.
   2. Qualification of Welders: Rules of procedure for qualification of all welders and general requirements for fusion welding shall conform with the applicable portions of ASME B31.9. The Contractor shall examine each welder to determine the ability of the welder to meet the required qualifications. Welders shall be tested for welds in all positions, including welds with the axis horizontal (not rolled) and with the axis vertical. Each welder shall weld only in positions in which they have qualified and identify welds with the specific code marking signifying name and number assigned. The Contractor shall furnish a list of welder's names and corresponding code markings. Welders which fail to meet the prescribed welding qualifications shall be retested. Welders who fail the second test shall be disqualified for work on this project.
   3. Radiographic Testing: An approved independent testing firm regularly engaged in radiographic testing shall perform radiographic examination of ten (10) randomly selected field welds in the piping in accordance with ASME B31.9.
      a. The following shall be furnished from the radiographic testing prior to installing casing field joints, backfilling and hydrostatic testing:

         1) A set of films showing each weld inspected

         2) A reading report evaluating the quality of each weld

         3) A location plan showing the physical location where each weld is to be found in the completed project.

      b. All radiographs shall be reviewed and interpreted by a Certified American Society for Nondestructive Testing Level III radiographer, employed by the testing firm, who shall sign the reading report. The Construction Manager may review all inspection records, and if any welds inspected are found unacceptable they shall be removed, rewelded, and radiographically reexamined at no cost to the Owner.

      c. Upon failure of any of the ten randomly tested welds, ten more randomly selected welds will be tested until there is a 100% passing of the welds inspected.

d. Radiographic testing shall be the responsibility of the mechanical contractor. The selection, hiring and coordination of testing times of the testing agency shall be done by the mechanical contractor. Final approval of the agency and testing shall be by the Engineer. The testing shall be coordinated with the owner and architect so a witness may be available for the testing.

B. Install in accordance with manufacturer's instructions.

C. Install heating water, glycol, chilled water, condenser water, and engine exhaust piping to ASME B31.9 requirements.

D. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

E. Route piping in orderly manner, parallel to building structure, and maintain gradient.

F. Install piping to conserve building space and to avoid interference with use of space.

G. Group piping whenever practical at common elevations.

H. Install firestopping to preserve fire resistance rating of partitions and other elements.

I. Slope piping and arrange to drain at low points.

J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
   1. Flexible couplings may be used in header piping to accommodate thermal growth, thermal contraction in lieu of expansion loops.
   2. Use flexible couplings in expansion loops.

K. Grooved Joints:
   1. Install in accordance with the manufacturer's latest published installation instructions.
   2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.

L. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

M. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1-1/2 inches minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   8. Provide copper plated hangers and supports for copper piping.
   9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

N. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

O. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors.

P. Use eccentric reducers to maintain top of pipe level.

Q. Seal exterior wall penetrations above grade weather tight.

R. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.

S. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.

T. Install valves with stems upright or horizontal, not inverted.

3.3 **TESTING**

A. Hydronic Piping shall be tested hydrostatically in accordance with latest edition of ASTM B31.9 and the following:

1. Other than ground source heat pump loop systems:
   a. Pressure: 1-1/2 times working pressure but not less than 100 psi.

   b. Duration: 15 minutes

2. PEX piping systems, testing may be with compressed gas as an alaternative to hydrostatic where compressed air when specifically authorized by the manufacuturer's insturctions for PEX piping and all fitings installed.

3.4 SCHEDULES

A. Space hangers so as to prevent sag and permit proper drainage. A hanger shall be placed within one foot of each horizontal elbow.

B. Hanger spacing to comply with all local code requirements.

END OF SECTION

SECTION 23 21 14 - HYDRONIC SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Expansion tanks.
B. Air vents.
C. Air separators.
D. Strainers.
E. Suction diffusers.
F. Flexible connectors.
G. Pressure-temperature test plugs.
H. Balancing valves and Flow meters.
I. Relief valves.

1.2 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2025, with Errata .
B. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi; 2004 (Reaffirmed 2017).

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
    1. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.
        a. Include applicable performance data for each specific device (flow rate, pressure drop, etc.).
    2. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.
C. Closeout Documents:
    1. Project Record Documents: Record actual locations of flow controls.
    2. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
    3. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
        a. See Section 01 60 00 - Product Requirements for additional provisions.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 EXPANSION TANKS

A. Manufacturers:
    1. Amtrol Inc: www.amtrol.com.
    2. ITT Bell & Gossett: www.bellgossett.com.

3. Taco, Inc: www.taco-hvac.com.
4. Grundfos.

B. Maximum Rated Working Pressure: 125 psi.

C. Maximum Allowable Service Temperature: 240 degrees F.

D. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, adjustable flexible EPDM diaphragm or bladder seal factory precharged to 40 psi with dry nitrogen, and steel support stand. Any field modifications of the tank pressure shall be performed by the mechanical contractor to match scheduled pressure. Any additions of air to the tank shall be provided with dry nitrogen and provide label with final fill pressure on tank.

E. Accessories: Provide air-charging fitting, epoxy coating finish, pressure gauge, and tank drain ball valve.

2.2 AIR VENTS

A. Manual Type: 1/2" ball valve with hose end installed on a "T" at all high points of each system to enable complete venting.

B. Float Air Vent:

1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

C. Maximum Fluid Pressure: 150 psi.

D. Maximum Fluid Temperature: 240 degrees F.

2.3 AIR SEPARATORS

A. Centrifugal Air Separators/Strainers:

1. Manufacturers:
   a. ITT Bell & Gossett: www.bellgossett.com.
   b. Taco, Inc: www.taco-hvac.com.
   c. Grundfos.
2. Primed steel body, tested and stamped in accordance with ASME BPVC-VIII-1 with integral bronze strainer, tangential flanged inlet and outlet connections, and internal stainless steel air collector tube.
3. Maximum Service Flow and Pressure: 4,500 gpm at 125 psi.
4. Accessories: Provide epoxy coating finish and removable strainer.

2.4 STRAINERS

A. Manufacturers:

1. Gustin-Bacon
2. Titan
3. Anvil
4. Keckley
5. MetraFlex.

B. Size 2 inch and Under:

1. Provide threaded, grooved, or sweat brass or iron body for up to 175 psi working pressure, Y-pattern strainer with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch:

1. Provide flanged or grooved iron body for 175 psi working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

D. Size 5 inch and Larger:

1. Provide flanged or grooved iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.5 SUCTION DIFFUSERS

A. Manufacturers:
1. Victaulic Company of America: www.victaulic.com.
2. Taco, Inc.
3. Bell & Gossett
4. Armstrong
5. Gustin-Bacon
6. Grundfos

B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.

C. Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping in side.

2.6 FLEXIBLE CONNECTORS

A. Manufacturers:
1. The Metraflex Company
2. Flexonics
3. Minnesota Flexible
4. Thermo-tech
5. Twin City Hose
6. EFP

B. Flexible Connectors (Molded Rubber):
1. Pipe connections to base mounted pump suction and discharge shall be made using flexible pipe connectors.
2. Flexible pipe connectors shall be constructed of nylon-reinforced neoprene spherical bodies double sphere type with 150 lb. steel flanges. Units shall include control rods or cables to prevent over-extension unless piping is anchored to eliminate such pipe movements.
3. Flexible pipe connectors shall be designed for not less than 150 psi working pressure and 230 degrees F working temperature. Connectors shall allow pipe movement of at least 1/2" to either side of centerline
4. Flexible connectors shall match the size of the piping serving the pump.

C. Flexible Connectors (Metal Braid Type): Flanged, braided type with wetted components of stainless steel, sized to match piping.
1. Pipe connections to chiller inlet and outlet shall be made using flexible pipe connectors.
2. Maximum Allowable Working Pressure: 150 psig at 120 degrees F.
3. End Connections: Same as specified for pipe jointing.
4. Provide necessary accessories including, but not limited to, swivel joints, internal guides, and control cables.

2.7 PRESSURE-TEMPERATURE TEST PLUGS

A. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.

B. Application: Use extended length plugs to clear insulated piping.

2.8 HOSE KITS AND VALVES

A. Manufacturers:
1. Bell & Gossett
2. Griswold Controls
3. Hays Fluid Controls
4. IMI Flow Design
5. Nexus

6. Victaulic
7. Nibco

B. Hoses:

1. Provide hoses for all units for connection to main water supply and return headers.
2. Length: 2 feet.
3. Material: Braided stainless steel rated to minimum 400 psi at 265 degrees F.

C. Manual Balancing Valves:

1. Brass or bronze body shutoff and hydronic balancing.
2. Balancing Valves to comply with "Balancing Valves" specification found in this section.

D. Vents:

1. Hose end ball valve with cap. No coin valve/vents allowed.

E. Drain:

1. Hose end ball valve with cap connected to strainer.

F. Ball Valves:

1. Brass body for shutoff and hydronic balancing.

2.9 BALANCING VALVES/Flow Meters

A. Manufacturers:

1. Flow Design
2. Gerand
3. Griswold
4. K.G.
5. Nexus
6. HCi
7. PRO Hydronic Specialties
8. Nibco
9. Tour & Anderson available through Victaulic Company of America

B. Calibrated ASME MFC-3M Venturi orifice plate and flanges with valved taps, chart for conversion of differential pressure readings to flow rate.

C. Annular element flow stations with meter set.

1. Venturi type flow meter fittings shall have a pressure drop at indicated flow not exceeding 10% of differential pressure reading.
2. Measuring Station: Type 316 stainless steel pitot type flow element inserted through welded threaded couplet, with safety shut-off valves and quick coupling connections, and permanent metal tag indicating design flow rate, reading for design flow rate, metered fluid, line size, station or location number.
   a. Pressure rating: 275 psi.
   b. Flow readings shall indicate the corrected solution flow reading based on 180 degrees F for hot water and 50 degrees F for chilled water. (Also anti-freeze solutions).
3. Flow meter fittings on pipe size 2" and under may be calibrated orifice type with integral tamperproof valve. Flow fitting meter shall be provided with quick connect couplings.
4. Orifice type flow fittings shall have an accuracy of not less than plus or minus 1% of actual flow. Orifice type flow meter fittings shall have a pressure drop at indicated flow not exceeding 25" of water.

D. Size 2 inch and smaller:

1. In addition to the previous noted balancing valves, manual globe style valves may be used.
2. Each valve to be wye pattern, globe style with self-sealing EPDM measurement points, EPDM seat, and wheel handles with locking tamper-proof setting.
3. Brass copper alloy body, EPDM o-ring seals. 4 turn digital readout hand wheel for balancing, hidden memory feature with locking tamper-proof setting. Brass shall be ISO 6509 compliant.

Manual globe style flow meter valves shall have a pressure drop at indicated flow not exceeding 25" of water.

2.10 RELIEF VALVES

A. Manufacturers:
   1. Apollo Valves: www.apollovalves.com/#sle.
   2. ITT Bell & Gossett: www.bellgossett.com.
B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.
B. Provide a manual air vent consisting of 1/2" ball valve with hose end installed on a "T" at all high points of each system to enable complete venting.
C. Provide air separator on suction side of system circulation pump and connect to expansion tank.
D. Provide valved drain and hose connection on strainer blowdown connection.
E. Install side stream filter across inlet and out let of closed system circulating pumps. Refer to details for installation.
F. Provide pump suction fitting on suction side of base-mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.
G. Support pump fittings with floor-mounted pipe and flange supports.
H. Provide relief valves on pressure tanks, low-pressure side of reducing valves, and heat exchangers.
I. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
J. Pipe relief valve outlet to nearest floor drain or glycol drum as noted on plans.
K. Where one line vents several relief valves, make cross-sectional area equal to sum of individual vent areas.
L. Perform tests determining strength of glycol and water solution and submit written test results.

END OF SECTION

SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Circulators.
B. In-line pumps.
C. End-suction pumps.

1.2 REFERENCE STANDARDS

A. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
C. Closeout Documents:
   1. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
   2. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      a. See Section 01 60 00 - Product Requirements, for additional provisions.
      b. Extra Pump Seals: two (2) for each type and size of pump.

1.4 QUALITY ASSURANCE

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Armstrong Pumps Inc: www.armstrongpumps.com.
B. Bell & Gossett, a Xylem Inc. brand: www.bellgossett.com.
C. Taco.
D. Grundfos.

2.2 GENERAL

A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
B. Base Mounted Pumps: Aligned by qualified millwright.
C. Electrical Requirements:
   1. Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.

2.3 IN-LINE PUMPS

A. Closed-Coupled, Single-Stage Pump: Vertical pump with radially-split casing; rated for discharge pressures up to 175 psi.
B. Casing: Cast iron with seal flush connection, threaded suction, and discharge ports with gauge port and drain plug.

C. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.

D. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.

E. All pump seals shall be suitable for use with water and/or a solution of 50% Glycol and water. The seals shall be rated to handle the following items as a minimum standard:

1. dissolved solids 25,000 ppm
2. undissolved solids 40 ppm
3. silica content 20 ppm

F. Pumps shall be selected with the scheduled capacities at 85% of the maximum impeller diameter for that model.

G. All circulating pump motors under 1/2 H.P. shall have built-in thermal overload protection.

H. Motors of pumps requiring variable frequency drives shall be provided with a shaft grounding system as required to prevent shaft current damage. This system shall be factory installed and shall be documented in maintenance manual. Manual shall include information on installation and maintenance of system with parts list and vendor name and address.

2.4 END-SUCTION PUMPS

A. Split-Coupled Pump: Base-mounted, single-stage pump with horizontal shaft and radially- or horizontally-split casing rated for discharge pressures up to 175 psi.

B. Casing: Cast iron or ductile iron with renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction, and discharge flanged connections with gauge ports.

C. Impeller: Stainless steel, balanced, fully enclosed, keyed to shaft.

D. Bearings: Permanently lubricated roller or ball bearings.

E. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.

F. All pump seals shall be suitable for use with water and/or a solution of 50% Glycol and water. The seals shall be rated to handle the following items as a minimum standard:

1. dissolved solids 25,000 ppm
2. undissolved solids 40 ppm
3. silica content 20 ppm

G. Pumps shall be selected with the scheduled capacities at 85% of the maximum impeller diameter for that model.

H. All circulating pump motors under 1/2 H.P. shall have built-in thermal overload protection.

I. Motors of pumps requiring variable frequency drives shall be provided with a shaft grounding system as required to prevent shaft current damage. This system shall be factory installed and shall be documented in maintenance manual. Manual shall include information on installation and maintenance of system with parts list and vendor name and address

J. Drive: Flexible coupling with coupling guard.

K. Baseplate: Cast iron or fabricated steel with integral drain rim.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. All in line circulating pumps with 5 hp and larger motor shall have factory startup.

C. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.

D. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close-coupled or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.

E. Provide air cock and drain connection on horizontal pump casings.

F. Check, align, and certify alignment of base-mounted pumps prior to start-up. Laser alignment of each pump shall be performed on site by a field certified technician. Provide start-up report.

G. Install base-mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 03 30 00.

H. Lubricate pumps before start-up.

END OF SECTION

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping.

1.2 RELATED REQUIREMENTS

A. Section 23 07 16 - HVAC Equipment Insulation.

1.3 REFERENCE STANDARDS

A. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2022, with Addendum (2024).

B. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2025, with Errata.

C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.

D. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2022.

E. ASME B31.9 - Building Services Piping; 2020.

F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.

G. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2023.

H. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.

1.4 SUBMITTALS

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

B. Shop Drawings:

1. Product Data: Provide general assembly of specialties, including manufacturer's catalogue information. Provide manufacturer's catalog data including load capacity.
2. Submit welders certification of compliance with ASME BPVC-IX.

C. Closeout Documents:

1. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.
2. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.
3. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   a. See Section 01 60 00 - Product Requirements, for additional provisions.
   b. Extra Filter-Dryer Cartridges: One of each type and size.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.

2.2 REGULATORY REQUIREMENTS

A. Comply with ASME B31.9 for installation of piping system.
B. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
C. Welders Certification: In accordance with ASME BPVC-IX.
D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

2.3 PIPING

A. Copper Tube: ASTM B280, H58 hard drawn or O60 soft annealed.
   1. Fittings: ASME B16.22 wrought copper.
   2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.
B. Pipe Supports and Anchors:
   1. Provide hangers and supports that comply with MSS SP-58.
      a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Carbon steel adjustable swivel, split ring.
   3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
   4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   5. Hangers for all piping shall be oversized to encircle the piping and the insulation, the insulation shall be continuous through all hangers.
   6. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
   7. Vertical Support: Steel riser clamp.
   8. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
   9. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
   10. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
   11. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
      a. Bases: High density, UV tolerant, polypropylene or reinforced PVC.
      b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
      c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
      d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
      e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.
      f. Manufacturers:

1) Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain-end ferrous pipe.
B. Remove scale and dirt on inside and outside before assembly.
C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

A. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
B. Install piping to conserve building space and avoid interference with use of space.
C. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
E. Pipe Hangers and Supports:
    1. Install in accordance with ASME B31.5.
    2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
    3. Place hangers within 12 inches of each horizontal elbow.
    4. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
    5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
    6. Provide copper plated hangers and supports for copper piping.
F. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
G. Provide clearance for installation of insulation and access to valves and fittings.
H. Flood piping system with nitrogen when brazing.
I. Insulate piping and equipment.
J. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
K. Fully charge completed system with refrigerant after testing.
L. Seal exterior wall penetrations above grade weather tight.

3.3 SCHEDULES

A. Piping hanger spacing shall comply with all local applicable codes.

END OF SECTION

SECTION 23 25 00 - HVAC WATER TREATMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Materials.
   1. System cleaner.
B. Glycol Equipment and Glycol
C. Side-stream filtration equipment.
D. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; 2025, with Errata.

1.2 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
   2. Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
C. Closeout Documents:
   1. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.
   2. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.
   3. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.
   4. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.
   5. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      a. See Section 01 60 00 - Product Requirements, for additional provisions.
      b. Sufficient chemicals for treatment and testing during required maintenance period.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.

1.4 REGULATORY REQUIREMENTS

A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems and to public sewage systems.
B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 MANUFACTURERS

2.2 MATERIALS

A. System Cleaner:

1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.
2. Passivates steel surfaces
3. Non-corrosive to base metals
4. Cleaner to be similar to Nalco #2567

2.3 **SIDE STREAM FILTER**

A. Shall be constructed and stamped in accordance with ASME BPVC-IV.

B. Filter housing shall be constructed of 304 stainless steel and brass. Housing shall be designed for use in high pressure (150 psi) systems. Housing shall be sized for flow listed on drawings.

C. Filter shall be 25 micron with metal core and shall be rated for use in 30°F to 210°F fluids containing up to 35% glycol. Provide two (2) extra sets of filter cartridges to owner.

D. Provide a in-line type sight flow indicator similar to Hedland EZ-View for measuring water flow through filter. Indicator shall be for flow listed on drawings, brass casing, magnet in metering tube with indicator protected by polycarbonate shield. Plastic casing shall not be acceptable.

2.4 **GLYCOL MAKE-UP TANK**

A. Drum shall be 55 gallons and mixed to proper concentration of system. See drawings for drum connection locations.

2.5 GLYCOL FILL PUMP

A. Pump shall be suitable for pumping a glycol solution. Pump capacity to be 3.0 G.P.M. at 40 psi discharge pressure with 10 ft of suction lift. Pump motor to be 1/2 H.P., 120 volt, single phase. Provide cord and plug. Provide flexible connection hoses in sizes indicated on plan.

2.6 **GLYCOL SOLUTION**

A. Manufacturers

1. Dow Chemical model Dowtherm SR-1, or Kurita model 9132

B. Type - Inhibited Ethylene

C. Glycol Solution:

1. Heating Hot Water: Inhibited glycol and water solution mixed 35 percent glycol - 65 percent water, suitable for operating temperatures from minus 30 degrees F to 210 degrees F.

PART 3 EXECUTION

3.1 PREPARATION

A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.

B. Place terminal control valves in open position during cleaning.

C. Verify that electric power is available and of the correct characteristics.

D. Clean and flush glycol system before adding glycol solution. Refer to Section 23 25 00.

E. Feed glycol solution to system through make-up connection as indicated on drawings. Vent system at high points to remove air and assure system is full. Set initial fill pressure at 5 psi (adjustable) at high point of system.

3.2 **CLEANING AND FLUSHING SYSTEM**

A. This contractor shall provide to the engineer an initial water analysis of the water intended to be used for filling the heating and/or cooling system in the building. The analysis shall identify any potential issues related to the chemical treatment or introduction of glycol into the system. Proper action shall be implemented to assure quality water is provided for system use. Analysis shall be performed by an

independent certified laboratory. Subsequent analysis as described herein shall be performed by the same laboratory.

B. When connecting to an existing system the contractor shall obtain a water sample and send it to an independent lab for analysis. Any existing water quality issues will be addressed by the owner upon receipt of the analysis.

C. This contractor shall thoroughly clean inside surface of boilers before placing them in operation. This shall include the use of caustic soda in the initial boiler water, thoroughly boiling out boiler, draining, flushing and refilling, all in accordance with the manufacturer's instructions. All dirt, grease, and other impurities shall be completely flushed out of the piping system as well as the boiler.

D. The entire new hot water heating system shall be filled with clean water and operated for a period of at least 72 hours and then drained and completely flushed of all dirt, grease and other impurities in the system. The contractor shall then refill with clean water, vent all air, and operated during the construction period and up until a period immediately prior to complete building acceptance by Owner.

E. Prior to complete acceptance of the building by the Owner, the entire hot water heating system shall again be drained, all strainers removed and cleaned, and the system again completely flushed of all dirt, grease and other impurities. This flushing of system shall be witnessed by the Architect's representative. At this time the entire new hot water heating system shall be refilled with water, corrosion inhibitors installed, all air vented out and the system placed in operation.

F. All chilled water and hot water systems shall be flushed as specified. The seals in the pumps shall be removed after the flushing, and prior to the building being turned over to the owner, new factory pump seals shall be installed. The pump seals used to flush the system shall be turned over to the owner.

G. This contractor shall provide the engineer with a water analysis upon completion of filling system. Water analysis shall indicate levels of inhibitors, quantities of impurities and PH level of water. Analysis shall be performed by a certified laboratory. Contactor shall provide a water analysis one year after system is placed in operation and provide additives to bring solution up to recommended levels. Testing shall be by an independent certified water testing laboratory at the contractors cost. Contractor shall provide a written statement indicating a one (1) year warranty on the installed water treatment system.

H. During all flushing, system fluid temperatures shall not exceed recommended temperatures from the pre-treatment suppliers recommendations.

I. Final flushing of the glycol piping system shall be done using a 1% solution of neutral PH iron cleaner prior to the introduction of the water-glycol mixture. Temperature of system fluids during final cleaning shall not be greater than chemical manufacturer’s recommendation. At this time the heating water piping circuit shall be refilled with water-glycol solution containing corrosion inhibitors, all air vented out, and the system placed in operation.

J. Contractor shall note special requirements for flushing radiant ceiling panel circuits prior to connecting panels. This will require a temporary by-pass at each circuit until the system is proven clean.

K. This contractor shall provide shop drawings indicating all glycol, chemical additives, cleaners, etc. Contractor shall provide a bill of lading for product used in system.

L. All hot water systems shall have corrosion inhibitors provided and installed after final cleaning.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide concrete housekeeping pad for floor mounted equipment and tanks.

3.4 **INTRODUCTION OF GLYCOL SOLUTION**

A. This contractor shall collect and test a sample from each vessel used to transport the glycol and/or solution to the project site. The analysis shall identify any potential issues related to the chemical treatment or introduction of glycol into the system. Analysis shall be performed by an independent certified laboratory.

B. The new heating coil piping circuit shall be filled with a 35% (+/- 2%) solution by volume of Dowtherm SR-1 heat transfer fluid. The solution shall be thoroughly mixed before being pumped into the piping systems. After the introduction of the solution into the piping systems, the systems shall be tested to insure a freezing protection temperature of -35°F.

C. This contractor shall provide a plastic laminated sign at the fill point of system. The sign shall be not less than 8-1/2" x 5" and shall be worded, "This system has been filled with a XX% solution of Dowtherm SR-1 (Dowfrost HD) and water. The solution should be tested each year for freezing protection and corrosion inhibitor."

D. It will be this contractor's option to provide factory premixed R.O. solution or provide proper water treatment to attain R.O. quality for the final fluid.

E. All glycol shall have surfactants and dispersants included in the inhibitor package of the glycol.

F. Contractor shall provide documentation from an independent lab indicating levels of glycol concentration, amount of minerals, etc. as described below in the system after solution is filled, again after one month & finally one year after system has been put into operation. Contractor shall provide additional fill of solution & shall make adjustments to the system fluid as required to provide acceptable limits as described by the independent lab test. The contractor shall retest and make adjustments until all values are considered acceptable. Acceptable range for system fluids include:

1. Clarity shall be considered "clear", (not cloudy).
2. Sediment shall have a wt% of <0.01.
3. Fluid shall have a PH level of 8-10.5.
4. Reserve alkalinity shall be >8 ml of 0.1N HCl.
5. Chloride levels shall be <100 ppm Cl.
6. Sulfate levels shall be <250 ppm SO4.
7. Total hardness shall be <200 ppm CaCO3.
8. Ferrous metal corrosion rate shall be <0.5 mils per year (mpy).
9. Copper corrosion rate shall be <0.5 mils per year (mpy).
10. Nitrite levels shall be <100 ppm NO2.
11. Nitrate levels shall be <100 ppm NO3.
12. Mercaptobenzothiazole levels shall be <100 ppm MBT.
13. Glycol in system shall be of the type specified and within 1% of the amount specified.
14. Glycols other than specified to be in system fluid shall be <1 % volume in the system.

END OF SECTION

SECTION 23 31 00 - HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Metal ducts.
B. Flexible ducts.
C. Ducts for kitchen exhaust applications.

1.2 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2017.
B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).
C. ASTM E2336 - Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems; 2025.
D. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
E. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.
F. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
G. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines; 2001.
H. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; 2012.
I. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.
J. UL 1978 - Grease Ducts; Current Edition, Including All Revisions.
K. UL 2221 - Tests of Fire Resistive Grease Duct Enclosure Assemblies; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Product Data: Provide data for duct materials.
C. Closeout Documents:
   1. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate per appropriate seal class, following SMACNA (LEAK).
   2. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.

1.5 FIELD CONDITIONS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide UL Class 1 ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A and SMACNA (DCS) guidelines unless stated otherwise.

B. Acoustical Treatment: Provide sound-absorbing liners and sectional silencers for metal-based ducts in compliance with Section 23 33 19.

C. Duct Material in accordance with Allowed Static Pressure Range:

1. Medium Pressure Supply (from supply fan to VAV inlet): 4 in-wc, galvanized steel
2. Low Pressure Supply (from VAV outlet to air outlet): 2 in-wc, galvanized steel
3. Low Pressure Supply: 2 in-wc, galvanized steel
4. Return and Relief: 2 in-wc, galvanized steel
5. General Exhaust: 2 in-wc, galvanized steel
6. Outside Air Intake: 2 in-wc, galvanized steel
7. Transfer Air and Sound Boots: 1 in-wc, galvanized steel
8. Dishwasher Exhaust: 1 in-wc, stainless steel
9. Grease Exhaust: 2 in-wc, 16-gage black iron, 18-gage stainless steel, or a listed and labeled factory built commercial kitchen grease duct

D. Duct Sealing and Leakage in accordance with Static Pressure Class:

1. As indicated above for duct material pressure class.

E. Duct Fabrication Requirements:

1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
2. Ductwork shall be fabricated of minimum 26 gauge galvanized metal.
3. Size round duct installed in place of rectangular ducts in accordance with ASHRAE (FUND) Handbook - Fundamentals.
4. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
5. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
6. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
7. Provide turning vanes of perforated metal with glass fiber insulation when an acoustical lining is required.
8. Provide transitions in duct size from trunk or runout ducts shown on the drawings to the inlet dimensions of any device connected to the duct. Transitions shall be sealed air tight.
9. Water tight drip pans shall be provided below all power vent, relief vent, gravity vent, fresh air and exhaust openings through roof, either built into the ductwork or, if no duct is installed, independently suspended below opening.

F. Dryer Venting:

1. All residential type clothes dryer exhaust ductwork shall be constructed of a minimum 26 gauge galvanized metal with all joints sealed air and water tight. The male end of the duct at overlapped duct joints shall extend in the direction of airflow. Sheet metal screws shall not extend into air stream. Provide weather proof dryer exhaust termination vent.
2. Provide a UL listed dryer box for each clothes dryer listed with an assembly providing a 1 hour fire stop rating. Dryer boxes shall be constructed of not less than 22 gauge aluminized steel and shall be provided with gas port knock-outs. Walls constructed of industry standard 2x4's shall utilize dryer boxes sized for 2x4 wall types. Walls constructed of industry standard 2x6 & larger shall utilize dryer boxes sized for 2x6 wall types. Dryer boxes shall be manufactured by In-O-Vate Technologies or approved equal.

2.2 METAL DUCTS

A. Material Requirements:

1. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.

B. Round Ducts

1. All supply duct shall be round spiral lockseam construction. Round duct shall be of standard spiral gauge as follows:

duct diameter	0-2 inches water column	>2-4 inches water column
Up to 8 inch	28 gauge	26 gauge
9 to 14 inch	28 gauge	26 gauge
15 to 26 inch	26 gauge	24 gauge
27 to 36 inch	24 gauge	22 gauge
37 to 42 inch	22 gauge	20 gauge
44 to 50 inch	22 gauge	20 gauge
52 to 60 inch	20 gauge	18 gauge
62 to 84 inch	18 gauge	18 gauge

2. Lockseam or ‘Snappy’ fittings and pipe shall not be allowed on any exposed round ductwork.
3. Duct shall be provided in continuous lengths, except where interrupted by fittings or diffuser takeoffs.
4. All branch takeoffs shall be made using high efficiency type takeoff fittings.
5. For all round ductwork up to and including 16” diameter, the duct sections shall be joined using a premanufactured coupling connection. When a connection is made, it shall be done by first coating the inside of the two pieces of ductwork thoroughly for approximately 3” with duct sealant. Duct sealant shall be used on fresh air ductwork & all outside & relief air ductwork within 15’ of building penetration as well as ductwork located in an attic space. Sealant shall be UL 181B-M listed and have a service range of -20 degrees F to 200 degrees F. The connector shall then be slid on so that the sealant is located between the outside wall of the connector and the inside wall of the ductwork. The coupling connection shall be attached to both pieces of ductwork it is connecting with either screws or rivets.
6. For all round ductwork 18” diameter and larger, the duct sections shall be joined together using a premanufactured Flange with Barrel Clamp type connector. Provide a neoprene gasket between the flanges to prevent air leakage. When a connection is made, it shall be done by first coating the inside of the two pieces of ductwork thoroughly for approximately 1-1/2 inches, or the length of the flanged connection, with Ductmate Proseal, indoor/outdoor, water based sealer, with 0 flame/smoke rating equal. Duct sealant shall be used on fresh air ductwork & all outside & relief air ductwork within 15’ of building penetration as well as ductwork located in an attic space. Sealant shall be UL 181B-M listed and have a service range of -20 degrees F to 200 degrees F. The flanged connectors shall then be slid on so that the sealant is located between the outside wall of the flanged connectors and the inside wall of the ductwork. The flanges shall be connected to both duct pieces with screws, rivets, or by spot welding.
7. For spaces without ceilings (other than mechanical rooms), exposed, uninsulated ductwork shall be galvanealed for field painting unless otherwise noted on plan. Paint color shall be selected by architect.
8. Wire rope hanging system may be used for support of round and/or ovalductwork. System shall be similar to Ductmate Cable Shark or Gripple. System shall consist of wire rope material with a locking mechanism for wire adjustment. Locking mechanism shall be installed according to manufacturer'r recommendations. Top termination of hanger shall be in accordance with SMACNA Standards.
9. Acceptable manufacturers include Norlock, Semco, Tangent Air, United McGill, Sheet Metal Connectors or approved equal.

2.3 Joint Sealers and sealants

A. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.

1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts. Sealant shall be gray in color or a color matching the duct system on which it is applied.
2. All fresh air intake and relief air ductwork between louver/hood and air handling unit shall have all joints sealed watertight. Sealant shall be UL 181B-M listed and have a service range of -20 degrees F to 200 degrees F.
3. All joints of low-pressure duct shall be carefully sealed to eliminate air leakage. Sealer shall be spread on the inside of all slips and longitudinal joints and then the duct assembled. Sealer shall be applied to all screw heads, connecting laps, and corner joints as well as all joints of flexible duct. Sealer shall be suitable for indoor/outdoor HVAC duct systems and shall be applied in accordance with manufacturer's recommendations. Duct sealants shall be U.L. Classified with a flame spread rating of 25 or less and a smoke developed rating of 50 or less. Sealants shall be UL 181B-M listed and have a service range of -20 degrees F to 200 degrees F
4. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
5. Manufacturers:
   a. Carlisle HVAC Products; Hardcast Iron-Grip 601 Water Based Duct Sealant: www.carlislehvac.com/sle.

2.4 FLEXIBLE DUCTS

A. Flexible Ducts: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound spring steel wire.
   1. Flexible duct shall meet NFPA 90A and 90B requirements and be UL listed 181 Class 1 Air Duct with a flame spread less than 25 and smoke developed less than 50.
   2. Insulation: Fiberglass R-6.0 insulation with polyethylene vapor barrier film.
   3. Maximum Velocity: 6000 fpm.
   4. Temperature Range: Minus 20 degrees F to 210 degrees F.
   5. Flex duct shall only be used in locations explicitly indicated on the drawings (generally limited supply air device connections and limited to 5 foot length without change in direction).
   6. Flex duct shall not be used above inaccessible ceilings.
   7. No flexible "duct connectors" shall be allowed.
   8. Manufacturers:
      a. Wiremold.
      b. Thermaflex.
      c. Flexmaster.
      d. Atco.

2.5 DUCTS FOR KITCHEN EXHAUST APPLICATIONS

A. Provide ductwork, fittings, and appurtenances in accordance with NFPA 96, SMACNA (KVS), UL 1978, and UL 2221 requirements and guidelines.

B. Class 1 duct for air with gas and grease particle exhaust at an air velocity of 1,500 to 2,500 fpm.

C. Where ducts are not self-draining back to equipment, provide low-point drain pocket with the copper drain pipe to a sanitary sewer.

D. Design, fabricate, and install liquidtight preventing exhaust leakage into building.

E. Dishwasher Exhaust Duct:
   1. Duct Size: 1 in-wc pressure class, stainless steel.
   2. Fabricate using 18 gauge, 0.050 inch thick, single wall sheet steel with continuous external welded joints to form rectangular sections.
   3. Flanged joints on the final section of ductwork shall be allowed for connection to terminal equipment. Flanged joints shall be carefully constructed and sealed. Ductwork shall slope back to

dishwasher. Ductwork shall be fabricated such that no joint connection extends into the air stream. A drain pan and ¾" drain shall be provided at the base of each vertical rise and any low point where water may collect. Provide a minimum of one drain per system. All drains shall be routed to the nearest floor drain or mop basin.

F. Kitchen Hood and Grease Exhaust Duct:
   1. Fabricate in accordance with ductwork manufacturer's instructions, SMACNA (DCS), SMACNA (KVS), and NFPA 96.
   2. 2 inch w.g. pressure class, 16-gage black iron, 18-gage stainless steel, or a listed and labeled factory built commercial kitchen grease duct.
   3. Joints, seams, and penetrations of grease ducts shall be made with a continuous liquid tight weld or braze made on the external surface of the duct system. Duct Joints shall be butt joints or overlapping joints of either the telescoping or bell type. The length of the overlap shall not exceed 2" and the difference between the inside cross-sectional dimension of overlapping sections shall not exceed 0.25 inches.
   4. Duct to exhaust fan connections shall be flanged and gasketed at the base of the fan for listed and labeled vertical discharge fans; shall be flanged, gasketed and bolted to the inlet of the fan for side inlet utility fans; and shall be flanged, gasketed, and bolted to the inlet and outlet of the fan for inline fans.
   5. Duct systems serving a Type I hood shall be constructed and installed so that grease cannot collect in any portion thereof, and the system shall slope not less than ¼ unit vertical in 12 units horizontal toward the hood or approved grease reservoir. Where horizontal ducts exceed 75' in length, the slope shall not be less than 1 unit vertical in 12 units horizontal.
   6. Zero Clearance, 2-Hour Fire-Rated, Round, Double-Wall, Premanufactured Grease Duct:
      a. UL Listed and labeled to UL 1978 and UL 2221.
      b. Nominal 3 inches thick, high density body soluble fiber insulation between 20-gauge, 0.035-inch Type 304 stainless steel liner, and 24-gauge, 0.0239-inch aluminized steel sheet outer jacket.
      c. Seal joints during installation with factory-supplied overlapping V-bands and sealant.
      d. Through-penetration firestop listed to UL 1479 or ASTM E814.
      e. Minimum horizontal slope of 1/16 inch per foot per manufacturers listing to UL 1978.
   7. Zero Clearance, 2-Hour Fire-Rated, Rectangular, Double-Wall, Premanufactured Grease Duct:
      a. Listed when tested in accordance with UL 1978 and ASTM E2336.
      b. Construct of 16-gauge, 0.059-inch sheet steel using continuous external welded joints in rectangular sections.
      c. Liquidtight with continuous external weld for seams and joints.
      d. Where ducts are not self-draining back to equipment, provide low-point drain pocket with copper drain pipe to sanitary sewer.
      e. Through-penetration firestop listed to UL 1479 or ASTM E814.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. All branch takeoffs shall be made using high efficiency type takeoff fittings similar to Sheet Metal Connectors Super HETO. All takeoffs shall be provided with a manual volume damper.

C. Install products following the manufacturer's instructions.

D. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.

E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

F. Flexible Ducts: Connect to metal ducts with duct sealer on inside and outside of flex duct as well as strap clamp around duct end. Tape outer jacket to diffuser neck..

G. Dryer Ducts: Label ductwork in concealed within buidling construction.

H. Kitchen Hood Exhaust: Provide residue traps at the base of vertical risers with provisions for the cleanout.

I. Grease Duct System Testing:

1. Prior to the use or concealment of any portion of a grease duct system, a leakage test shall be performed to determine that all welded joints and seams are liquid tight. Ducts shall be considered to be concealed where they are installed in shafts or covered by coatings or wraps that prevent the duct from being visually inspected on all sides. It is permissible to test the duct in sections, provided that, after the duct system is completely assembled, all field-assembled joints are tested, including the duct-to-hood connection. When the testing is performed in this manner, only the field-assembled joints of listed factory-built grease ducts are required to be tested. The leakage test shall consist of a light, air, or water test, or an approved equivalent test. The permit holder shall be responsible to provide the necessary equipment and perform the grease duct leakage test.

a. The light test shall be performed by passing a lamp having a power rating of not less than 100 watts through the entire section of ductwork to be tested. The lamp shall be open so as to emit light equally in all directions perpendicular to the duct walls. No light from the duct interior shall be visible through any exterior surface.

b. The air test shall be performed by sealing the entire duct system from the hood exhaust opening(s) to the duct termination. The sealed duct system shall then be pressurized to a minimum pressure of 1.0 inch water column and shall be required to hold the initial set pressure for a minimum of 20 minutes.

c. The water test shall be performed by use of a pressure washer operating at a minimum of 1,500 psi, simulating cleaning operations. The water shall be applied directly to all areas to be tested. No water applied to the duct interior shall be visible on any exterior surface in any volume during the test.

J. Where duct liner is installed in ducts, the duct size indicated accommodates the liner such that the gross duct dimension is that shown on the drawings. No increase in duct size is necessary to accommodate duct liner thickness.

K. Provide openings in ductwork as indicated to accommodate thermometers and controllers. Provide pilot tube openings as indicated for testing of systems, complete with metal can with spring device or screw to insure against air leakage. For openings, insulate ductwork and install insulation material inside a metal ring.

L. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

M. Use double nuts and lock washers on threaded rod supports.

N. Provide galvanized iron drip pans under water, soil, waste, drain or heating system piping which runs over electric switchboards, elevator controllers, or electric motor starters. Drip pans shall have all joints and seams soldered water tight. Each drip pan shall have a drain piped to discharge where shown on the drawings, or if not shown, to discharge over nearest available drain.

O. Sealing of Ductwork:

1. Joints of all supply, return and exhaust ducts shall be carefully sealed to eliminate air leakage. Sealer shall be spread on the inside of all slips and longitudinal joints and then duct assembled. Sealer shall also be applied to exterior to all joints. Sealant shall be UL 181B-M listed and have a service range of -20 degrees F to 200 degrees F.
2. Seal all ductwork to seal class A. This will require all ductwork to have all joints, seams and wall penetrations sealed. Sealing must be sufficient to achieve a leakage class 6. This means that 6 CFM of leakage per 100 sq ft of duct surface is the maximum allowable threshold if tested at 1 inch test pressure. See additional duct sealing requirements in the latest edition of the SMACNA manual "HVAC Air Duct Leakage Test Manual."
3. If review of the testing and balancing report reveals duct leakage in excess of the leakage class 6, the contractor shall be required to seal the ductwork in place. Duct sealing shall be as follows:
    a. Repair all major leakage sites (> ½ inch across) using mastic and fiberglass mesh tape.

    b. Assure the structural integrity of all mechanical joints of existing ductwork using mastic and fiberglass mesh tape.

    c. Seal existing ductwork from the inside using automated, UL Certified, aerosolized sealant injection as manufactured by Aeroseal

    d. Protect air-moving equipment, air inlets and outlets, and other devices and appurtenances as recommended by the manufacturer.

    e. Protect occupied spaces from aerosol particles using manufacturer procedures.

    f. Provide pre-sealing, post-sealing and sealing profile certificates for all sections sealed.

    g. Seal all injection and test holes in existing ductwork using patching plates sealed with mastic.

    h. Any insulation (internal or external) shall be replaced on the patching plate.

4. Sealant shall be applied neatly. Satisfactory appearance shall be maintained on all exposed ductwork.

P. Testing and Adjusting

1. The supply ductwork shall be pressure tested by Mechanical Contractor to assure minimal duct leakage. The Testing and Balancing sub-contractor shall supply testing equipment for this contractor to pre-test all ductwork prior to the Testing and Balancing sub-contractors verification of leakage. It shall be the Mechanical Contractor's responsibility to coordinate and schedule duct installation and the associated pressure testing with the testing and balancing sub-contractor, prepare all ductwork for leak testing, and to make all necessary modifications to the ductwork to meet the duct air tightness requirements as stated herein and as recommended by the Testing and Balancing Contractor.
2. An extra set of Mechanical drawings shall be supplied to the Testing and Balancing Contractor at the beginning of the project, so that the leak testing percentages can be written on the print for each section of ductwork during the leak testing process. Depending upon capacity of testing equipment, the exact size and length of duct sections that can be tested will vary. Confirm and coordinate duct section sizes with Testing and Balancing sub-contractor. Progress reports of pressure testing shall be submitted at intervals of 25%, 50%, 75% and 100% of work completed. Refer to Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC of these specifications for more information.

END OF SECTION

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Backdraft dampers - metal.
B. Duct access doors.
C. Duct test holes.
D. Volume control dampers.
E. Motor Operated Dampers
F. Miscellaneous Products:
   1. Internal strut end plugs.
   2. Duct opening closure film.

1.2 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
   2. Indicate for shop fabricated assemblies including volume control dampers.
C. Closeout Documents:
   1. Project Record Drawings: Record actual locations of access doors and test holes.
   2. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      a. See Section 01 60 00 - Product Requirements for additional provisions.

      b. Extra Fusible Links: One of each type and size. Additional links shall be turned over to the Owner at the end of the project.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
B. 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 dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.1 BACKDRAFT DAMPERS - METAL

A. Manufacturers:
   1. Nailor Industries, Inc: www.nailor.com.
   2. Pottorff: www.pottorff.com/#sle.
   3. Ruskin Company, a brand of Johnson Controls: www.ruskin.com.
   4. Greenheck: www.greenheck.com
   5. Loren Cook: www.lorencook.com

B. Backdraft dampers shall be the counterbalanced type, with a screw type adjustment. Flanges shall be provided on either the intake or discharge side of the damper depending on installation needed in the curb.

C. Damper blades shall consist of an extruded aluminum channel frame 0.063 in. thick, with 2 in. depth. The blades shall be 0.05 in. thick, extruded aluminum. Damper manufacturer's printed application and performance data including pressure, velocity and temperature limitations shall be submitted for approval. Damper shall be suitable for pressures to 2.5 in. wg, velocities to 2,000 ft./min and temperatures to 180 °F. Testing and ratings to be in accordance with AMCA Standard 500.

D. The mechanical contractor shall work with the testing and balancing contractor to insure the dampers are adjusted during balancing to properly control building pressurization.

E. Spring type dampers will not be allowed.

F. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Extruded aluminum, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

G. Backdraft dampers shall have an air leakage rate not greater than 20 cfm/sq ft. where not less than 24 inches in either dimension and 40 cfm/sq ft. where less than 24 inches in either dimension. Leakage rate shall be at a pressure of 1.0" w.c.

2.2 DUCT ACCESS DOORS

A. Manufacturers:

1. Nailor Industries, Inc: www.nailor.com.
2. Ruskin Company, a brand of Johnson Controls: www.ruskin.com.
3. Cesco Advanced: www.cescoproducts.com
4. Kees: www.kees.com
5. National Controlled Air: www.ncamfg.com
6. Vent Products: www.ventproducts.com
7. Aire Technologies:www.airetechnologies.com

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Provide access doors with framed edges, equipped with latches in ductwork for inspection of all automatic operated dampers and terminal heating, etc.

D. Access doors for round ducts shall be rectangular and shall be constructed in accordance with SMACNA HVAC Duct Construction Standards (latest edition). Access door dimensions shall not be less than 2" smaller than duct diameter. The door shall be provided with a handle and retaining ring. Access doors shall be equal to Ductmate, Model FD1 (rectangular door).

E. Access doors for rectangular ducts shall be similar to Air Balance Model FSA 101 and constructed of 24 gauge galvanized steel with a 1" thick insulated door, frame and double cam latches. Frame shall be gasketed to minimize air leakage.

F. Access doors for fire dampers, smoke dampers and fire/smoke dampers shall be a minimum of 12”x 12” in size. Increase duct size as required for access door installation.

G. All duct access doors shall be accessible through walls, ceilings or floors. Provide access doors as required to reach duct access doors.

H. Access doors with sheet metal screw fasteners are not acceptable.

2.3 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

1. Manufacturers:

a. Carlisle HVAC Products; Dynair Test Port with Red Cap with O-Ring Seal: www.carlislehvac.com/#sle.

2.4 VOLUME CONTROL DAMPERS

A. Manufacturers:
1. Nailor Industries, Inc: www.nailor.com.
2. Pottorff: www.pottorff.com/#sle.
3. Ruskin Company, a brand of Johnson Controls: www.ruskin.com.
4. Aire Technologies: www.airetechnologies.com
5. Greenheck: www.greenheck.com

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Each register and diffuser air terminal shall be provided with a damper in the duct leading to the air terminal. Each branch duct leading to a group of two or more air terminals shall be provided with a damper at the point where the branch leaves the main duct. Dampers shall be installed with a maximum of 1/8" clearance all around. Dampers shall be installed so that they can be adjusted at any time after completion of the work, and shall be fitted with "Parker", or equal, damper quadrants. Quadrants shall be plainly marked to indicate position of damper. All dampers shall be tight fitting and be reinforced to prevent vibration. Damper handles shall be extended type for insulation clearance.

D. Balancing dampers serving the inlet of a VAV box shall be installed in the size indicated for the high efficiency take off serving the VAV (not VAV inlet size). VAV inlet dampers shall be similar to Duro Dyne Corp. HDJD damper with continuous rod for 2” wg and over. Dampers shall be constructed of a minimum 22 gauge galvanized steel blades with high strength corrosion resistant 3/8” square rod extending 3 inches beyond the blade to accommodate exterior duct insulation. Dampers shall be provided with regulators similar to Duro Dyne ESO with a stand height of 1-1/2” to accommodate insulation thickness & designed for square shafts with locking wing nut to secure damper while balancing. Where damper shafts penetrate through the duct, a closed end bearing shall be installed on the end without the regulator and an open end bearing on the regulator end.

E. Where damper shafts penetrate duct walls, the openings shall be properly sealed to eliminate air leakage.

F. Each damper handle, where located above a lay-in tile ceiling, shall be identified by attaching section of flagging tape to the end of the damper handle. Length of flagging tape shall be approximately 12” long with longer or shorter lengths determined based on location of installation and clearance requirements. The flagging tape shall be high visibility, similar to pink or orange, to allow for ease of locating damper locations.

G. Where dampers are located in ducts concealed above non-accessible ceiling, the dampers shall be equipped with Ventlock concealed, flush cap regulators.

H. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.
1. Manufacturers:
a. Carlisle HVAC Products; Dynair End Bearing Leak Resistant Sets: www.carlislehvac.com/#sle.

b. Elgen Manufacturing Company, Inc; Snap-In Bushing: www.elgenmfg.com/#sle.

I. Quadrants:
1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
3. Where rod lengths exceed 30 inches provide regulator at both ends.
4. Manufacturers:
a. Carlisle HVAC Products; Dynair Double Shear Rattle Free Quadrants 1/2 inch: www.carlislehvac.com/#sle.

2.5 **MOTOR OPERATED DAMPERS**

A. All automatic motor operated louver dampers shall be furnished and set in place by this contractor. In addition to the ventilation drawings, the contractor shall refer to the automatic temperature control diagrams for locations of where motorized dampers are required. It shall be the responsibility of this contractor to verify all damper locations and sizes for the job. Furnish this information to the temperature control subcontractors so that they may provide the appropriate motors for the dampers.

B. Insulated, thermally broken dampers

1. Damper frame shall be insulated with styrofoam on four sides and be thermally broken by means of polyurethane resin pockets complete with thermal cuts. Blades shall be extruded aluminum, internally insulated with expanded polyurethane foam and shall be thermally broken. Damper blades shall be permanently secured to blade shaft. Blade shaft shall mount to frame with double bearing allowing rod to rotate while outer bearing remains fixed. Blade and frame seals shall be of extruded silicone and be secured in an integral slot within the aluminum extrusion. Dampers shall be not more than 48 inches in length between bearings. Modulating dampers shall be of the opposed blade type. Dampers when closed shall be guaranteed by the manufacturer not to leak in excess of 5 cfm per square foot at 4 inches water gauge static pressure and -40° F. Dampers shall be installed with operators having sufficient power to limit leakage to the rate specified. Dampers shall have channel frames, and all parts of dampers shall be minimum of 0.075” thickness extruded aluminum.
2. Acceptable manufacturers shall be Tamco, Arrow, Greenheck, or Ruskin.

2.6 MISCELLANEOUS PRODUCTS

A. Internal Strut End Plugs: Combination end-mounting and sealing plugs for metal conduit used as internal reinforcement struts for metal ducts; plug crimped inside conduit with outside gasketed washer seal.

1. Manufacturers:
   a. Carlisle HVAC Products; Dynair Internal Duct Reinforcement - Conduplugs: www.carlislehvac.com/#sle.

B. Duct Opening Closure Film: Mold-resistant, self-adhesive film to keep debris out of ducts during construction.

1. Thickness: 2 mils.
2. High tack water based adhesive.
3. UV stable light blue color.
4. Elongation Before Break: 325 percent, minimum.
5. Manufacturers:
   a. Carlisle HVAC Products; Dynair Duct Protection Film: www.carlislehvac.com/#sle.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). See Section 23 31 00 for duct construction and pressure class.

B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, before turning vanes on duct mains, and elsewhere as indicated. Provide minimum 12 by 12 inch size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch for balancing dampers only. Review locations prior to fabrication.

D. Provide duct test holes where indicated and required for testing and balancing purposes.

E. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

F. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum two duct widths from duct take-off.

G. Provide balancing dampers on high velocity systems where indicated. See Section 23 36 00.

H. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

I. Provide balancing dampers on all takeoffs serving terminal devices.

END OF SECTION

SECTION 23 33 19 - DUCT SILENCERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Duct silencers.
   1. Absorptive silencers.

1.2 REFERENCE STANDARDS

A. AHRI 270 (SI/I-P) - Sound Performance Rating of Outdoor Unitary Equipment; 2025.
B. AHRI 575 - Method of Measuring Machinery Sound Within an Equipment Space; 2017.
C. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.
D. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.
E. AMCA 302 - Application of Sone Loudness Ratings for Non-Ducted Air Moving Devices; 1973 (Reaffirmed 2012).
F. AMCA 303 - Application of Sound Power Level Ratings for Fans; 1979 (Reaffirmed 2012).
G. ANSI S1.13 - American National Standard Measurement of Sound Pressure Levels in Air; 2020 (Reaffirmed 2025).
H. ANSI S12.1 - American National Standard Guidelines for the Preparation of Standard Procedures to Determine the Noise Emission from Sources; 1983 (Reaffirmed 2023).
I. ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
J. ASHRAE Std 68 - Laboratory Method of Testing to Determine the Sound Power in a Duct; 1997.
K. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; Most Recent Edition Cited by Referring Code or Reference Standard.
L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.
M. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Product Data: Provide catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance.
   2. Indicate assembly, materials, thicknesses, dimensional data, pressure losses, acoustical performance, layout, and connection details.
   3. Design Data: Provide engineering calculations, referenced to specifications and AHRI 270, AMCA 301, AMCA 302, AMCA 303, and ANSI S12.1 standards indicating that maximum room sound levels are not exceeded.
   4. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers.
C. Closeout Documents:
   1. Manufacturer's Installation Instructions: Indicate installation procedures necessary to maintain integrity of sound isolation.
   2. Manufacturer's Field Reports: Indicate installation is complete and in accordance with instructions.
   3. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Perform Work in accordance with AHRI 575, AMCA 300, or ANSI S1.13 standards and recommendations of ASHRAE Std 68.

PART 2 PRODUCTS

2.1 DUCT SILENCERS

A. Manufacturers:
   1. Price Industries, Inc: www.priceindustries.com.
   2. Vibro-Acoustics: www.vibro-acoustics.com/#sle.
   3. United McGill: www.mcgillairsilence.com/index_noise.html
   4. VAW Systems

B. Description: Duct section with sheet metal outer casing, sound absorbing fill material, and inner casing of perforated sheet metal; incorporating interior baffles of similar construction. Fabricate in accordance with SMACNA (DCS) HVAC Duct Construction Standards.

C. General Requirements:
   1. Casing, sealants, adhesives, accessory materials, and packing materials to comply with ASTM E84.
   2. Airstream surfaces installed in a return air plenum to comply with requirements in ASHRAE Std 62.1.
   3. Factory-fabricated, field-installed products.

D. Materials:
   1. Outer Casing: Minimum 22 gauge, 0.0299 inch thick galvanized steel stiffened as required, with mastic filled lock formed seams, 2 inch long, 11 gauge, 0.1196 inch slip joints on both ends.
   2. Inner Casing and Splitters: Minimum 24 gauge, 0.0239 thick perforated galvanized steel.
   3. Fill: Glass fiber or mineral wool of minimum 4 lb/cu ft density.
   4. Fill Liner: Bonded glass fiber matting.

2.2 PERFORMANCE REQUIREMENTS

A. Use acoustical devices to maintain sound level of spaces at levels not to exceed those listed below.

B. Maintain rooms at the following maximum sound levels, in Room Criteria (RC) as defined by ASHRAE (HVACA) Handbook - HVAC Applications.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Support duct silencers independent of ducts with flexible duct connections, lagged with leaded vinyl sheet on inlet and outlet. See Section 23 31 00 and Section 23 33 00.

3.2 SYSTEMS STARTUP

A. Inspect installation periodically. Prepare and start systems.

END OF SECTION

SECTION 23 34 13 - AXIAL HVAC FANS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Destratification fans.

1.2 REFERENCE STANDARDS

A. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.
B. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Product Data: Provide data on axial fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
   2. Indicate assembly of axial fans and accessories including fan curves with specified operating point clearly plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
   3. Test Reports: Indicate performance data for adjustable axial fan blades for at least five blade settings, including maximum.
C. Closeout Documents:
   1. Manufacturer's Instructions: Indicate installation instructions.
   2. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
   3. Maintenance Materials: Furnish the following for the Owner's use in the maintenance of the project.
      a. See Section 01 60 00 - Product Requirements for additional provisions.
      b. Extra Fan Belts: One set for each individual fan.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect motors, shafts, and bearings from weather and construction dust.

1.6 FIELD CONDITIONS

A. Do not use permanent fans for ventilation during construction.

PART 2 PRODUCTS

2.1 **DESTRATIFICATION FANS**

A. Manufacturers:
   1. Airius Model: Air Pear
   2. Zoo
B. Description
   1. Thermal equalizer to create uniform temperature between ceiling and floor.
   2. Installed in an array fashion in large spaces with high ceilings/structure.

C. Construction:
   1. Multi-vane stator to provide axial flow
   2. Compact design, PC/ABS construction
   3. Conforms with UL 507
   4. Guard/Grille: powder coated steel
   5. Safety cable

D. Electrical
   1. ECM motors
   2. Voltage/phase as scheduled.

E. Controls
   1. Coordinate circuiting with Division 26 and temperature controls
   2. Provide factory controller for fan operation and speed.
      a. Include capability to control and monitor temperature differential between ceiling and floor.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. All mechanical equipment shall be lubricated. All equipment shall be operated for a period of sufficient duration to insure its proper mechanical operation.

END OF SECTION

SECTION 23 34 23 - HVAC POWER VENTILATORS AND EXHAUST SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Roof exhausters.
B. Cabinet exhaust fans.
C. Kitchen hood upblast roof exhausters.

1.2 REFERENCE STANDARDS

A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
B. AMCA 99 - Standards Handbook; 2025.
C. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2020.
D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.
E. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.
F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.
G. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
H. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.
I. UL 705 - Power Ventilators; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Product Data: Provide data on fans and accessories, including fan curves with specified operating point plotted, power, rpm, sound power levels at rated capacity, and electrical characteristics and connection requirements.
C. Closeout Documents:
   1. Manufacturer's Instructions: Indicate installation instructions.
   2. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
   3. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      a. See Section 01 60 00 - Product Requirements, for additional provisions.
      b. Extra Fan Belts: One set for each individual fan.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.1 **MANUFACTURERS (UNLESS NOTED OTHERWISE BELOW)**

A. Greenheck Fan Corporation: www.greenheck.com.
B. Loren Cook Company: www.lorencook.com.
C. Twin City Fan & Blower: www.tcf.com/#sle.

2.2 POWER VENTILATORS - GENERAL

A. Static and Dynamically Balanced: Comply with AMCA 204.

B. Performance Ratings: Comply with AMCA 210, bearing certified rating seal.

C. Sound Ratings: Comply with AMCA 301, tested to AMCA 300, bearing certified sound ratings seal.

D. Fabrication: Comply with AMCA 99.

E. UL Compliance: UL 705, listed, labeled, designed, manufactured, and tested.

F. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

G. Enclosed Safety Switches: Comply with NEMA EN 10250.

H. Provide fans sized with maximum RPM at 10% above scheduled RPM.

2.3 ROOF EXHAUSTERS

A. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.

B. Roof Curb: 24 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips and R-10 insulation.

C. Disconnect Switch: Factory wired, nonfusible, in housing for thermal overload protected motor.

D. Motorized Damper: motorized actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked.

E. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm gets attained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.4 CABINET EXHAUST FANS

A. Centrifugal Fan Unit: Direct driven with galvanized steel housing lined with acoustic insulation, resiliently mounted motor, gravity backdraft damper in discharge.

B. Ceiling mounted exhaust fans shall be of the centrifugal direct drive type. The fan housing shall be constructed of steel. The access for wiring shall be external. The motor shall mounted on vibration isolators. The fan wheel shall be of the forward curved centrifugal type and dynamically balanced. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance and shall be UL/cU/listed.

C. Duct mounted exhaust, supply or return air fans shall be of the centrifugal direct drive type. The fan housing shall be constructed of steel. The steel duct collar shall accept round ductwork. The access for wiring shall be external. The motor shall mounted on vibration isolators. The fan wheel shall be of the forward curved centrifugal type and dynamically balanced. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance and shall be UL/cUL Listed.

D. Disconnect Switch: Factory wired, nonfusible, in housing for thermal overload protected motor.

E. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is reached with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.5 KITCHEN HOOD UPBLAST ROOF EXHAUSTERS

A. Belt Drive Fan:

1. Fan Wheel:

a. Type: Non-overloading, backward inclined centrifugal.

b. Material: Aluminum, statically and dynamically balanced.

2. Housing:
   a. Construct of heavy gauge aluminum including curb cap, windband, and motor compartment.

   b. Rigid internal support structure.

   c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.

   d. Construct drive frame assembly of heavy gauge steel, mounted on vibration isolators.

   e. Provide breather tube for fresh air motor cooling and wiring.

B. Shafts and Bearings:
   1. Fan Shaft:
      a. Ground and polished steel with anti-corrosive coating.

      b. First critical speed at least 25 percent over maximum cataloged operating speed.

   2. Bearings:
      a. Permanently sealed or pillow block type.

      b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.

      c. 100 percent factory tested.

C. Drive Assembly:
   1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
   2. Belts: Static free and oil resistant.
   3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
   4. Motor pulley adjustable for final system balancing.
   5. Readily accessible for maintenance.

D. Disconnect Switches:
   1. Factory mounted and wired.
   2. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.

      b. Outdoor Locations: Type 3R.

   3. Finish for Painted Steel Enclosures: Provide manufacturer's standard or factory-applied gray unless otherwise indicated.
   4. Positive electrical shutoff.
   5. Wired from fan motor to junction box installed within motor compartment.

E. Upblast power ventilators for grease exhaust shall be provided with vented curbs furnished in sizes suitable for the vent served. Each shall be 24" high. Curbs shall be factory assembled units, thermo-insulated with not less than 1½” glass fiber insulation and constructed of 18 gauge welded galvanized iron with built-in cant strip.

F. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

G. Options/Accessories:

1. Clean Out Port: Removable grease repellent compression rubber plug allows access for cleaning wheel through windband.
2. Roof Curb Extension: Vented curb extension where required for compliance with minimum clearances required by NFPA 96.
3. Drain Connection:
   a. Aluminum construction.

   b. Container allows single-point drainage of grease, water, or other residues.

4. Finishes: Standard factory finish.
5. Grease Trap:
   a. Aluminum.

   b. Built-in drain connection.

   c. Container system to collect grease residue.

6. Hinge Kit:
   a. Aluminum hinges.

   b. Hinges and restraint cables mounted to base sleeve.

   c. Allows fan to tilt away for access to wheel and ductwork for inspection and cleaning.

7. Heat Baffle: Prevents heat from radiating into motor compartment.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof exhausters with cadmium plated steel lag screws to roof curb.

C. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.

D. Install backdraft dampers on inlet to roof and wall exhausters.

E. Provide motorized damper on outlet from cabinet and ceiling exhauster fans and as indicated.

F. All mechanical equipment shall be lubricated. All equipment shall be operated for a period of sufficient duration to insure its proper mechanical operation.

G. Any changing of pulley sizes if found necessary when testing systems, shall be done by this contractor. Any additional dampers which may be found necessary to get proper air supply and quantity shall be furnished by this contractor at no expense to the Owner.

END OF SECTION

SECTION 23 36 00 - AIR TERMINAL UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Single-duct terminal units.

1.2 REFERENCE STANDARDS

A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).
B. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2017 (Reaffirmed 2023).
C. ASHRAE Std 130 - Laboratory Methods of Testing Air Terminal Units; 2025.
D. ASTM A492 - Standard Specification for Stainless Steel Rope Wire; 1995 (Reapproved 2019).
E. ASTM A603 - Standard Specification for Metallic-Coated Steel Structural Wire Rope; 2019.
F. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2025.
G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
H. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; 2024.
I. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements.
   2. Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
      a. Include schedules listing discharge and radiated sound power level for each of the second through sixth-octave bands at inlet static pressures of 1 to 4 in-wc.
   3. Certificates: Certify that coils are tested and rated in accordance with AHRI 410.
C. Closeout Documents:
   1. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.
   2. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.
   3. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.
   4. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
   5. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      a. See Section 01 60 00 - Product Requirements for additional provisions.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 SINGLE-DUCT, VARIABLE-VOLUME UNITS

A. Manufacturers:
1. Price Industries, Inc: www.priceindustries.com.
2. Trane, a brand of Ingersoll Rand: www.trane.com.
3. Titus: www.titus-hvac.com
4. Enviro-tec: www.enviro-tec.com
5. Nailor Industries Inc[<>]: www.nailor.com.

B. General:
1. Factory-assembled, AHRI 880 (I-P) rated and bearing the AHRI seal, air volume control terminal with damper assembly, flow sensor, externally mounted volume controller, duct collars, and all required features.
2. Control box bearing identification, including but not necessarily limited to nominal cfm, maximum and minimum factory-set airflow limits, coil type and coil (right or left hand) connection, where applicable.
3. Units shall deliver the maximum scheduled cfm with an air pressure drop not to exceed 0.35”, including all accessories listed below.

C. Unit Casing:
1. Minimum 22 gauge, 0.0299 inch galvanized steel.
2. Air Inlet Collar: Provide round, suitable for standard duct sizes.
3. Unit Discharge: Rectangular, with slip-and-drive connections.
4. Provide control cabinet enclosure mounted to VAV box. Control Cabinet access door shall match construction of VAV box.
5. Acceptable Liners:
a. 1/2 inch thick, coated, fibrous-glass complying with ASTM C1071. All terminal coil casings shall be constructed and insulated to the same standard as the VAV box.
1) Secure with adhesive.
2) Coat edges exposed to airstream with NFPA 90A approved sealant.
3) Cover liner with non-porous foil.
b. Liner not to contain pentabrominated diphenyl ether (CAS #32534-81-9) or octabrominated diphenyl ether.

D. Damper Assembly:
1. Heavy-gauge, galvanized steel, or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating bearings.
2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.
3. Incorporate low leak damper blades for tight airflow shutoff.
a. Air Leakage Past Closed Damper: Maximum two percent of unit maximum airflow at 3 in-wc inlet static pressure, tested in accordance with ASHRAE Std 130.

E. Hot Water Heating Coil:
1. Coil Casing: Minimum 22 gauge, 0.0299 inch galvanized steel, factory-installed on terminal discharge with rectangular outlet, duct connection type.
a. Access Door: Gasketed, cam-lock latches, and insulated located on bottom.
b. Right or left coil inlets. Coordinate prior to ordering.

2. Coil Fins: Aluminum or aluminum plated fins, mechanically-bonded to seamless copper tubes.
3. Coil leak tested to minimum 350 psig.
4. Base performance data on tests run in accordance with AHRI 410 and units to bear AHRI 410 label.

F. Controls:

1. DDC (Direct-Digital Controls):
   a. See Section 23 09 23. Controls for VAV box shall be furnished by the temperature controls contractor for field mounting,

2. Airflow Sensor: Differential pressure airflow device measuring total, static, and wake pressures.
   a. Signal accuracy: Plus/minus five percent throughout terminal operating range.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that conditions are suitable for installation.

B. Verify that field measurements are as indicated on drawings.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install the inlets of air terminal units and air flow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.

C. See drawings for the size(s) and duct location(s) of the air terminal units.

D. Provide ceiling access doors or locate units above easily removable ceiling components.

E. Support units individually from structure with wire rope complying with ASTM A492 and ASTM A603 in accordance with SMACNA (SRM). See Section 23 0548.

F. Do not support from ductwork.

G. Connect to ductwork in accordance with Section 23 31 00.

3.3 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to zero percent full flow.

3.4 CLEANING

A. Vacuum clean coils and inside of units.

END OF SECTION

SECTION 23 37 00 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 Section Includes

A. Registers, Diffusers, and Grilles
B. Louvers

1.2 Reference Standards

A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; 2023.
B. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Air Inlets; 2023.

1.3 Submittals

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
C. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

1.4 Quality Assurance

A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
B. Test and rate louver performance in accordance with AMCA 500-L.
C. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.1 Manufacturers

A. Krueger-HVAC, Division of Air System Components: www.krueger-hvac.com.
B. Price Industries: www.price-hvac.com/#sle.
C. Titus, a brand of Air Distribution Technologies: www.titus-hvac.com.
D. Tuttle and Bailey: www.tuttleandbailey.com/#sle.
E. Nailor: www.nailor.com

2.2 REFER TO DRAWINGS AND SCHEDULES FOR REQUIRED DIFFUSERS, GRILLES, AND REGISTERS.

2.3 Louvers

A. Manufacturers:
   1. Ruskin Company
   2. Greenheck
B. Type: 6 inch deep with blades on 45 degree slope, heavy channel frame, 1/2 inch square mesh screen over exhaust and 1/2 inch square mesh screen over intake.
C. Fabrication: No less than 0.081" thick extruded aluminum welded assembly, with factory enamel finish.
D. Color: To be selected by Architect from manufacturer's standard range.
E. Louvers used as a direct inlet to the space shall be furnished with insect screens on the inside of the louver face.
F. Mounting: Furnish with interior flat flange for installation.

PART 3 EXECUTION

3.1 Installation

A. Install in accordance with manufacturer's instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to ductwork with air tight connection.

D. Paint ductwork visible behind air outlets and inlets matte black, see Division 09.

END OF SECTION

SECTION 23 52 16 - CONDENSING BOILERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Manufactured units.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete.
B. Section 23 09 13 - Instruments and Control Elements.
C. Section 23 21 14 - Hydronic Specialties.
D. Section 23 25 00 - HVAC Water Treatment.
E. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

A. ASHRAE Std 103 - Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers; 2022, with Errata (2025).
B. ASME CSD-1 - Controls and Safety Devices for Automatically Fired Boilers; 2021.
C. NFPA 31 - Standard for the Installation of Oil-Burning Equipment; 2024.
D. NFPA 54 - National Fuel Gas Code; 2024.
E. NFPA 58 - Liquefied Petroleum Gas Code; 2024, with Amendment.
F. UL 641 - Type L Low Temperature Venting Systems; Current Edition, Including All Revisions.
G. UL 795 - Commercial-Industrial Gas Heating Equipment; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Division 01 - Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.
C. Closeout Documents:
   1. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.
   2. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect boilers from damage by leaving factory inspection openings and shipping packaging in place until final installation.

1.6 WARRANTY

A. Provide a five year warranty to include coverage for heat exchanger.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

A. Factory assembled, factory fire-tested, self-contained, readily transported unit ready for automatic operation except for connection of water, fuel, electrical, and vent services.

B. Unit: Metal membrane wall, water or fire tube, condensing boiler on integral structural steel frame base with integral fuel burning system, firing controls, boiler trim, insulation, and removable jacket, suitable for indoor application.

C. Appliance shall be listed in accordance with the requirements of ANSI Z21.13 or UL 795.

D. If applicable, the boiler shall be designed and constructed in accordance with the requirments of ASME CSD-1 and as applicable, the ASME Boiler and Pressure Vessel Code, Sections I, II, IV, V and IX and NFPA 85 (IFGC 631.1)

E. Operating Instructions shall be permenantly attached to boiler.

F. Manufacturer's rating data and nameplate data shall be attached.

G. Annual Fuel Utilization Efficiency (AFUE): 0.82 in accordance with ASHRAE Std 103.

2.2 CONDENSING HOT WATER BOILERS

A. Manufacturers:
1. Fl
2. Lochinvar
3. Thermal Solutions

B. Boiler shall be natural gas fired, fully condensing, fire tube design. Power burner shall have full modulation and discharge into a positive pressure vent. Boiler efficiency shall increase with decreasing load, while maintaining setpoint. Boiler shall be factory assembled and tested. Boiler shall be a fire-tube condensing boiler constructed with a heavy gauge steel jacket assembly. The combustion chamber shall be sealed. A burner/flame observation port shall be provided.

C. The heat exchanger shall be constructed of 316L stainless steel with a one-pass combustion gas flow through design. The heat exchanger shall be ASME stamped for a working pressure not less than 160 psig and shall be National Board Listed.

D. The boiler water connections shall be flanged 150-pound, ANSI rated. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.

E. The boiler burner shall have a 10-to-1 turndown ratio of the firing rate. The burner shall be constructed of high temperature stainless steel with a woven metal fire outer covering to provide modulating firing rates. It shall be supplied with a gas valve designed with negative pressure regulation and be equipped with a variable speed blower system, to control the fuel/air mixture to provide modulating firing rates for maximum efficiency.

F. The boiler shall include a variable-speed, centrifugal fan to operate during the burner firing sequence and pre-purge the combustion chamber. Ignition shall be via spark ignition with 100 percent main-valve shutoff and electronic flame supervision.

G. Minimum boiler thermal efficiencies shall be 92% as registered with AHRI and shall operate up to 99% with return water temperatures at 90°F or below.

H. The flue collector/condensate basin shall be of corrosion resistant 316 Stainless Steel with a round flue connection. The exhaust manifold shall have a collecting reservoir and a drain.

I. The boiler control system shall utilize a 24VAC control circuit and components. The control system shall have a Liquid Crystal touch screen display for boiler set-up, boiler status and boiler diagnostics. All components shall be easily accessed and serviceable from the front of the jacket.

J. The boiler control shall include the following features:
1. Built in Cascading Sequencer for multiple boiler.
2. BMS Integration with 0-10vDC
3. BACnet MSTP communications to the BAS.
4. Outdoor Reset
5. Password security
6. Inlet & Outlet Temperature Readout
7. Freeze Protection
8. Service Reminder

9. Time Clock
10. Data Logging
11. Night Setback
12. Pump Control - System Pump, Boiler Pump & Domestic Water Pump

K. The boiler shall have the following connections:

1. High Voltage Terminal Strip
   a. 120VAC / 60HZ / 1 Phase Power Supply
   b. System, Boiler and Domestic Pump Contacts
2. Low Voltage Terminal Strip
   a. 24 VAC Aux Device Relay
   b. Three Aux Proving Switch Contacts
   c. Alarm on Any Failure Contacts
   d. Runtime Contacts
   e. DHW Tank Thermostat Contacts
   f. Unit Enable/Disable Contacts
   g. System Sensor Contacts
   h. DHW Tank Sensor Contacts
   i. Cascade Contacts
   j. 0-10VDC BMS External Control Contacts
   k. 0-10VDC Boiler Pump Output Contacts
   l. Outdoor Air Sensor Contacts

L. Each boiler shall include the following trim, controls and/or safety devices:

1. Temperature/Pressure Gauge
2. High Limit Temperature Control with Manual Reset
3. ASME 60PSI Relief Valve
4. Outlet Water Temperature Sensor
5. Return Water Temperature Sensor
6. Outdoor Air Sensor
7. Flue Temperature Sensor
8. High & Low Gas Pressure Switches
9. Low Water Cutoff with Manual Reset & Test
10. Condensate Trap

M. Provide solid head plugs on any crosses, tees, etc., located in the piping around the boilers.

N. The integral cascading sequencer will control up to 8 boilers using a 2-wire daisy chain connection. On demand, one boiler functions as the leader and modulates to capacity. Increasing load will “cascade” to additional “lag” boilers in sequence as needed. Lead-lag rotation shifts the “first-on” boiler role every 24hrs, distributing equal run times to each unit.

O. Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the boiler.

P. This contractor shall provide a flue gas analysis for each boiler obtained during boiler startup to assure compliance to heaters parameters. A copy of the analysis shall be included in the O&M Manuals for future reference. Gas ports are to be furnished in the boiler venting. Gas ports shall be closed and sealed when not in use. Holes drilled in wall of vent piping and sealed with tape will not be acceptable.

Q. Equipment start-up shall be performed by a factory trained service technician employed by the representative of the equipment manufacturer. Start-up shall include the start-up procedure as required by the equipment Installation and Maintenance Manuals. Manufacturer representative shall warrant the parts and labor of the equipment for 12 months from the date of start-up.

2.3 GAS VENT(S): (Condensing Gas Appliances)

A. MANUFACTURERS

1. AMPCO by Hart & Cooley, Inc; Model VSI: www.ampcostacks.com/#sle.
2. DuraVent; DuraStack Pro (DIS2): www.duravent.com/#sle.
3. Metal-Fab, Inc: www.mtlfab.com/#sle.
4. Security Chimneys International; Secure Stack Pro (CIX2): www.securitychimneys.com/#sle.
5. Selkirk Corporation; Model PS: www.selkirkcommercial.com/#sle.
6. Z-Flex U.S. Inc: www.z-flex.com/#sle.
7. Schebler
8. Enervex Powerstack

B. Gas vent(s) shall be type AL 29-4C superferritic stainless steel (or 316L-PCM), double wall vent piping suitable for horizontal or vertical venting. Outer wall pipe shall be stainless steel. Vent pipe and fittings shall be suitable for use with Listed Natural Gas or Propane Gas burning condensing equipment which produces continuous flue gas temperatures not above 550°F. The system is to be installed and sealed per manufacturers instructions so all joints are gas tight preventing leakage of products of combustion into a building. Fastening method shall not allow penetration of the flue gas conduit by any lower alloy fasteners.

C. Furnish and install the number of sections in lengths as required to obtain the gas vent termination indicated on the drawings and as per manufacturer’s recommendations. Gas vent shall be installed complete with necessary fittings, flashings, accessories, etc., for a complete and operating system.

D. Provide a drain tee with cap at each boiler outlet. Provide a drain tee with cap for every 30’ of horizontal run. Horizontal gas vent shall be installed with slope to allow condensate drainage. All installation shall be in accordance with the manufacturer’s recommendations.

E. Provide section of vent piping with gas analysis ports built in. Provide plugs to seal ports when not in use.

F. Gas vents shall be tested and listed in accordance with standards of UL 1738.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Boiler shall be field tested, adjusted and set per manufacturer.

C. Install boiler and provide connection(s) to natural gas service, liquified petroleum gas service, fuel oil service or combination of these services in accordance with requirements of either NFPA 31, NFPA 54, NFPA 58, and all applicable codes.

D. Boilers with input greater than 400 MBh shall be designed and constructed in accordance with current edition of ASME Code and National Board Inspection.

E. Install boiler and provide connection of natural gas service in accordance with requirements of NFPA 54 and applicable codes.

F. Install boiler on concrete housekeeping base, sized minimum of 4 inches larger than boiler base.

G. Coordinate factory installed controls with Section 23 09 13.

H. Coordinate provisions for water treatment in accordance with Section 23 25 00.

I. Pipe relief valves to glycol barrel.

J. Pipe cooled condensate produced by the combustion process from the boiler condensate connection and/or flue stack with suitable piping material to neutralizer prior to discharging into nearest floor drain.

K. Provide piping connection and accessories in accordance with Section 23 21 14.

L. Provide for connection to electrical service in accordance with Division 26.

M. Vent Installation shall conform to the manufacturer’s installation instructions, its UL/cUL listing and state/local codes.

N. The vent system and breechings shall be inspected and cleaned before the final connection to the appliances.

3.2 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate operation of system to Owner's personnel.
   1. Use operation and maintenance data as reference during demonstration.
   2. Conduct walking tour of project.
   3. Briefly describe function, operation, and maintenance of each component.

B. Training: Train Owner's personnel on operation and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of two hours of training.
   3. Instructor: Manufacturer's training personnel.
   4. Location: At project site.

END OF SECTION

SECTION 23 73 13 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

<<< UPDATE NOTES

PART 1 GENERAL

2.1 SECTION INCLUDES

A. Casing construction.
B. Fan section.
C. Coil section.
D. Filter and air cleaner section.
E. Damper section.

2.2 RELATED REQUIREMENTS

A. Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
B. Section 23 34 13 - Axial HVAC Fans.
C. Section 23 34 16 - Centrifugal HVAC Fans.
D. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

2.3 REFERENCE STANDARDS

A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).
B. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
C. AMCA 99 - Standards Handbook; 2025.
D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.
E. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.
F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.
G. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2018.
H. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2025.
I. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
J. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

2.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation of air handler with size, location and installation of service utilities.
B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
C. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

2.5 SUBMITTALS

A. See Division 01 - Administrative Requirements for submittal procedures.
B. Shop Drawings:
   1. Product Data:

a. Published Literature: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials, and electrical characteristics and connection requirements.

b. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.

c. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.

d. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.

e. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

2. Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

C. Closeout Documents:

1. Specimen Warranty: Submit sample of manufacturer's warranty.
2. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
3. Manufacturer's Instructions: Include installation instructions.
4. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.
5. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   a. See Section 01 60 00 - Product Requirements for additional provisions.

   b. Extra Fan Belts: One set for each unit.

   c. Extra Filters: Two sets for each unit.

2.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

2.7 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by testing firm acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.

2.8 DELIVERY, STORAGE, AND HANDLING

A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

C. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

3.1 MANUFACTURERS

A. Carrier Corporation

B. Daikin Applied

C. Trane Inc

D. York International Corporation / Johnson Controls Inc

E. Petra.

F. Duct connections and equipment clearances were based on the manufacturer scheduled. Any deviations in size and/or configuration shall be the responsibility of the contractor. Air handling units by other approved manufacturers will be acceptable if of a similar type and grade and if of approximately the same general overall dimensions. Quality, construction and performance must be equal to or better than that specified.

3.2 CASING CONSTRUCTION

A. Full Perimeter Base Rail:
   1. Construct of galvanized steel.
   2. Provide base rail of sufficient height to raise unit for external trapping of condensate drain pans.
   3. In addition to the internal isolation of the fan/motor, the entire unit shall be isolated from the floor with neoprene pads. Provide Mason Super W neoprene pad between the base rails and the housekeeping pad or floor. The pad shall be installed under entire length of air handling unit. Pads shall be 4" wide by 3/4" thick.

B. Casing:
   1. Construct of one piece, insulated, double wall panels. Panels and access doors shall be constructed as a 2-inch thick, thermal broke double wall assembly, injected with foam insulation for an R-value of not less than R-13
   2. Provide mid-span, no through metal, internal thermal break.
   3. Construct outer panels of G90 galvanized steel and inner panels of G90 galvanized steel.
   4. A sound baffle shall be secured to the inner liner of all fan sections and constructed of G90 galvanized perforated steel filled with 3 lb. per cu ft. density, neoprene coated, glass fiber insulation.
   5. Casing Air Pressure Performance Requirements:
      a. Able to withstand up to 8 in-wc positive or negative static pressure.

      b. The casing leakage rate shall not exceed 0.5 CFM per square foot of cabinet area at 6 inches of negative static pressure or 5 inches of positive static pressure.

      c. Not to exceed 0.0042 inches per inch deflection at 1.5 times design static pressure up to a maximum of plus 8 in-wc in positive pressure sections and minus 8 in-wc in negative pressure sections.

      d. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket. Module to module assembly shall be accomplished with an overlapping, full perimeter, insulated, internal splice joint sealed with bulb type gasketing on both mating modules.

   6. Manufacturer shall provide shipping splits in the air handler casing as required for moving the unit into the building through existing openings. The contractor shall verify the maximum section size to fit through existing openings. If any the unit sections are too large to fit, they shall be disassembled enough to move the equipment through the opening and then reassembled in the mechanical space.

C. Access Doors:
   1. Construction, thermal and air pressure performance same as casing.
   2. Access doors shall be flush mounted to cabinetry, with minimum of two six inch long stainless steel piano-type hinges, latch and handle assembly.
   3. Door shall swing outward for unit sections under negative pressure, or inward for unit sections under positive pressure.
   4. Door gaskets shall be bulb-type W shaped.

5. All access doors shall be a minimum of 16” wide.
6. Provide surface mounted handles on hinged, swing doors.

D. Unit Flooring: Construct with sufficient strength to support expected people and equipment loads associated with maintenance activities.

E. Casing Leakage: Seal joints and provide airtight access doors so that air leakage does not exceed one percent of design flow at the specified casing pressure.

F. Insulation:

1. Provide minimum thermal thickness of 13 R throughout.
2. Completely fill panel cavities in each direction to prevent voids and settling.
3. Comply with NFPA 90A.

G. Finish:

1. Indoor Units:
   a. Provide exterior, galvanized steel panels.
   b. Color: Manufacturer's standard color.

3.3 FAN SECTION

A. Type: Forward curved, single width, single inlet, centrifugal plug type fan, conforming to AMCA 99. Refer to Section 23 3413.

B. Performance Ratings: Determined in accordance with AMCA 210 and labeled with AMCA Certified Rating Seal.

C. Sound Ratings: AMCA 301; tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.

D. Fan assemblies including fan, motor and sheaves shall be dynamically balanced by the manufacturer on all three planes and at all bearing supports.

E. Bearings: Self-aligning, grease lubricated, with lubrication fittings extended to exterior of casing with copper tube and grease fitting rigidly attached to casing near access door.

F. All fan motors shall be premium efficiency. All motors of air handlers requiring variable frequency drives shall be provided with a shaft grounding system as required to prevent shaft current damage. This system shall be factory installed and shall be documented in maintenance manual. Manual shall include information on installation and maintenance of system with parts list and vendor name and address.

G. Mounting:

1. Locate fan and motor internally on welded steel base coated with corrosion resistant paint.
2. Factory mount motor on slide rails.
3. Provide access to motor, drive, and bearings through removable casing panels or hinged access doors.

H. External Motor Junction Box: Factory mount NEMA 4 external junction box and connect to extended motor leads from internally mounted motors.

I. Drives:

1. Comply with AMCA 99.

3.4 COIL SECTION

A. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.

B. Air Coils:

1. Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410.
2. Drain and vent connections shall be provided exterior to unit casing.

C. Fabrication:

1. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.
2. Fins: Aluminum.
3. Casing: Die formed channel frame of galvanized steel.

D. Water Heating Coils:

1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
2. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes.
3. Heating coils shall have a maximum of 10 fins per inch.

3.5 FILTER AND AIR CLEANER SECTION

A. General: Provide filter sections with filter racks, minimum of one access door for filter removal, and filter block-offs to prevent air bypass. Filter media efficiency shall be as scheduled with flat or angle arrangement as shown on the drawings.

B. Contractor shall install a set of filters in each air handler when the unit is installed. Filters shall be replaced with new before turning the building over to the owner.

C. Throwaway Filters:

1. Media: 2 inch fiberglass with rigid supporting mesh across the leaving face, capable of operating up to a maximum of 500 fpm without loss of efficiency and holding capacity.
2. Frame: Rigid.
3. Minimum Efficiency Reporting Value: 5 MERV when tested in accordance with ASHRAE Std 52.2.

D. Differential Pressure Gauge:

1. Provide factory installed dial type differential pressure gauge, flush mounted with casing outer wall, and fully piped to both sides of each filter to indicate status.
2. Maintain plus/minus 5 percent accuracy within operating limits of 20 degrees F to 120 degrees F.
3. Provide across each filter section a differential pressure gauge with 4” dial and +/-2% full scale accuracy. Gauge(s) shall be similar to Dwyer Model #2001 (0” to 1”) and Dwyer Model #2002 (0” to 2”). Provide all necessary copper or aluminum tubing and mounting hardware to install gauge(s).

3.6 **DAMPER SECTION**

A. Damper Blades:

1. Double-skin low-leak, airfoil design with metal, compressible jamb seals and extruded-vinyl blade-edge seals on each blade.
2. Self-lubricating stainless steel or synthetic sleeve bearings. Dampers shall have stainless steel jamb seals along end of dampers. Linkage and ABS plastic end caps shall be provided.
3. Comply with ASHRAE Std 90.1 I-P for rated maximum leakage rate.
4. Provide leakage testing and pressure ratings in compliance with AMCA 500-D test methods. Damper leakage rate shall be less than two tenths of one percent leakage at 2 inches static pressure differential.
5. Arrange in parallel or opposed-blade configuration.

3.7 VARIABLE FREQUENCY DRIVE

A. Refer to section 23 09 13 - Instruments and Control Elements on requirements for variable frequency drives.

PART 3 EXECUTION

4.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Bolt sections together with gaskets.

C. Make connections to coils with unions or flanges.

D. Hydronic Coils:
   1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
   2. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line.
   3. Locate water supply at bottom of supply header and return water connection at top.
   4. Provide manual air vents at high points complete with stop valve.
   5. Ensure water coils are drainable and provide drain connection at low points.

E. All mechanical equipment shall be lubricated. All equipment shall be operated for a period of sufficient duration to insure its proper mechanical operation.

F. Any changing of pulley sizes if found necessary when testing systems, shall be done by this contractor. Any additional dampers which may be found necessary to get proper air supply and quantity shall be furnished by this contractor at no expense to the Owner.

4.2 SYSTEM STARTUP

A. Provide manufacturer's field representative to perform systems startup.

B. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.

C. Adjust for proper operation within manufacturer's published tolerances.

D. Manufacturer representative shall warrant the parts and labor of the equipment for 12 months from the date of start-up.

4.3 CLOSEOUT ACTIVITIES

A. Demonstrate proper operation of equipment to Owner's designated representative.

B. Training: Train Owner's personnel on operation and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Instructor: Manufacturer's training personnel.

END OF SECTION

SECTION 23 74 13 - PACKAGED OUTDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Packaged roof top unit.

B. Roof mounting curb and base.

C. Maintenance service.

1.2 RELATED REQUIREMENTS

A. Section 07 72 00 - Roof Accessories: Placement and installation of factory fabricated roof mounting curbs.

B. Section 23 09 13 - Instruments and Control Elements: Control components, time clocks.

C. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.

1.4 SUBMITTALS

A. See Divisoin 01 - Administrative Requirements for submittal procedures.

B. Shop Drawings:

1. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
2. Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
3. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.

C. Closeout Documents:

1. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
2. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
3. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   a. See Section 01 60 00 - Product Requirements for additional provisions.
   b. Extra Filters: Two sets for each unit.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect units from physical damage by storing off site until roof mounting curbs are in place, ready for immediate installation of units.

PART 2 PRODUCTS

2.1 ROOF TOP HEATING AND AIR CONDITIONING UNITS:

A. Each unit shall be a complete DX cooling with hot water heat unit with low matching component parts designed specially for roof top installation. Each unit shall contain an air cooled condensing unit with easily removable hail guards for condensing coil and hot water coil and a mixing damper section containing fresh air, return air and exhaust air dampers. Each unit shall be furnished with roof curb for an extended duct system. Units shall be UL listed and labeled. All units shall be factory assembled, internally wired, and 100 percent run-tested before leaving the factory.

B. All units shall be fully charged with refrigerant.

C. All cabinets shall be constructed of galvanized steel (20 gauge or heavier) and have a weather-resistant enamel finish. Casings shall be double wall fully insulated in sections where conditioned air is handled with a minimum of R-13 insulation. All access doors shall be double wall fully insulated. Access doors shall be flush mounted to cabinetry, with piano-type hinges and tool free access doors (handles, not screws or bolts). Units shall be completely weatherproof and furnished with lifting lugs. Unit roof shall be sloped or cross-broken to assure drainage.

D. Filters in filter boxes shall be Farr 30-30 2" thick throwaway type. Filter arrangements and boxes shall be as indicated on the drawings.

E. Fans and motors shall be installed on a frame independently isolated from the rooftop housing with spring type vibration isolators. The discharge of the fan shall be isolated from the housing by a flexible connection. Belt drives shall be furnished with belt guards.

1. Unit shall be provided with supply fan and exhaust fan sections.

F. Motors shall be isolated from frames with isolation mounts equal to Mason N-A Red Mounting for 40-90 lb. Load range (up to 3 HP), NDB Black Mounting for 50-100 lb. load range (5 & 7-1/2 HP) and NDB Green Mounting for 75-150 lb. Load range (10 HP). For loads or HP’s higher than these consult the factory for appropriate isolators.

G. Refrigerant compressors shall be resiliently mounted and have overload protection and crankcase heater. The refrigerant system shall have suction and liquid line service gauge ports, high pressure switch, loss of charge switch, check and expansion valves, suction line accumulator, thermometer well, dryer, freezestat and full refrigerant charge. Condensing unit section shall be provided with a hail guard. Provide low sound condenser fan package. Cooling performance shall be rated in accordance with DOE and/or ARI testing procedures. Provide variable speed inverter scroll compressor for unloading.

H. Provide factory-installed refrigerant monitoring system for unit compliant with ASHRAE 15 and all local codes.

I. Refrigerant coils shall be constructed of aluminum fins mechanically bonded to copper tubes. All coils shall be leak tested. Unit shall be furnished with a sloped drain pan below coils and piped to exterior of unit. Multiple circuit cooling coils shall be interlaced type.

J. Hot water coils shall be installed in the units and rated for 35% glycol/water mixture. The coils shall meet the performance as scheduled.

K. Units as scheduled shall be provided with a heat wheel. Enthalpy recovery wheel rotor media shall be cleanable. All media surfaces shall be coated with a non-migrating solid adsorbent layer prior to being formed into the honeycomb media structure to insure that all surfaces are coated and that adequate latent capacity is provided. Desiccant coatings that are sprayed on or dip coated, or desiccants that must be reapplied over time are not acceptable. The desiccant shall be specifically developed for the selective adsorption of water vapor. Sensible and latent recovery performance and pressure loss data from independent tests conducted in accordance with ASHRAE Standard 84 shall be provided. Cross-contamination performance reports shall also be provided. The desiccant media shall be cleanable with low temperature steam, hot water, or light detergent, without degrading the latent recovery. Dry particles up to 800 microns shall freely pass through the media.

L. The heat recovery section shall be provided with a motor for the heat wheel and all required bypass dampers.

M. Unit shall be mounted on a factory furnished 24" roof curb with minimum of R-12 insulation and with a wood nailer strip. Roof curbs shall be constructed of galvanized steel. Curbs are to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasketing shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.

N. Mixing damper section shall contain fresh air, return air and exhaust air dampers. Bird screen and suitable hoods for weather-proofing air inlets and exhaust outlets shall be provided. A modulating damper motor factory linked and installed within mixing damper section shall be provided.

O. Controls shall be DDC by controls contractor.

P. Unit shall have single point power connection. Field power connections, control interlock terminals and unit control system shall be enclosed in a weather tight enclosure. Power and starting components shall include factory fusing of fan motors and control circuit, starting contactors, compressor sequence start timer, compressor overload protection on all three phases, factory installed non-fused disconnect switch, and factory installed control power transformer with GFI outlet on unit exterior. Unit shall be furnished complete with all safety and operating controls.

Q. Unit shall be supplied with provisions for the installation of an in-duct smoke detector within the supply and return sections of the unit. Smoke detector shall be provided and installed by the fire alarm contractor and installed within the unit at the location determined by the roof top unit supplier.

R. Each roof top heating and air conditioning unit shall be furnished with a complete wiring diagram showing all required field wiring to include auxiliary switches, dual control switch on damper motors, etc.

S. Roof top units shall be furnished as scheduled on the drawings.

T. Variable Frequency Drive

1. Refer to section 23 09 13 - Instruments and Control Elements on requirements for variable frequency drives.

U. All units shall be provided with hail guards.

V. All access doors shall be a minimum of 18" wide.

W. Acceptable manufacturers shall be Aaon, Addison, York, Daikin, Trane, Greenheck, Petra or an approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings.

B. Verify that proper power supply is available.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 90A.

C. Mount units on factory built roof mounting curb providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.

D. All mechanical equipment shall be lubricated. All equipment shall be operated for a period of sufficient duration to insure its proper mechanical operation.

3.3 SYSTEM STARTUP

A. Prepare and start equipment. Adjust for proper operation. Equipment start-up shall be performed by a factory trained service technician employed by the representative of the equipment manufacturer. Start-up shall include the start-up procedure as required by the equipment Installation and Maintenance Manuals. Manufacturer representative shall warrant the parts and labor of the equipment for 12 months from the date of start-up.

3.4 CLOSEOUT ACTIVITIES

A. Demonstrate operation to Owner's maintenance personnel.

3.5 MAINTENANCE

A. Provide service and maintenance of packaged roof top units for one year year from Date of Substantial Completion.

B. Provide routine maintenance service with a two month interval as maximum time period between calls.

C. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of two filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibration.

D. After each service call, submit copy of service call work order or report that includes description of work performed.

END OF SECTION

SECTION 23 81 26.13 - SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Air cooled condensing units.
B. Indoor air handling (fan and coil) units for ductless systems.
C. Controls.

1.2 RELATED REQUIREMENTS

A. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections and installation and wiring of thermostats and other controls components.

1.3 REFERENCE STANDARDS

A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2008, Including All Addenda.
B. AHRI 270 (SI/I-P) - Sound Performance Rating of Outdoor Unitary Equipment; 2025.
C. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; 2004.
D. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2022, with Addendum (2024).
E. ASHRAE Std 23 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Compressor Units; 2022.
F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
G. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.
H. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

1.4 SUBMITTALS

A. See Division 01 - Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
   2. Indicate assembly, required clearances, and location and size of field connections.
   3. Design Data: Indicate refrigerant pipe sizing.
   4. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
C. Closeout Documents:
   1. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
   2. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
   3. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      a. See Section 01 60 00 - Product Requirements, for additional provisions.
      b. Extra Filters: One for each unit.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Mitsubishi
B. LG
C. Daikin
D. Samsung
E. Haier

2.2 SYSTEM DESIGN

A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
   1. Heating: None.
   2. Cooling: Outdoor electric condensing unit with evaporator coil in central ducted indoor unit.
   3. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.
B. Performance Requirements: See Drawings for additional requirements.

2.3 INDOOR AIR HANDLING UNITS FOR DUCTLESS SYSTEMS

A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.
   1. Location: High-wall.
   2. Cabinet: Galvanized steel.
      a. Finish: White.
   3. Fan: Line-flow fan direct driven by a single motor.
   4. Filter return air with washable, antioxidant pre-filter and a pleated anti-allergy enzyme filter.
B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
   1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
   2. Manufacturer: System manufacturer.

2.4 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
   1. Comply with AHRI 210/240.
   2. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
   3. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23 and UL 207.
   4. Sound Rating: 69 dBA, when measured in accordance with AHRI 270 (SI/I-P).
B. Compressor: Scroll, variable speed, AHRI 520 resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high-pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.
C. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
   1. Condenser Fans: Direct-drive propeller type.
   2. Condenser Fan Motor: Enclosed, 1-phase type, permanently lubricated.
D. Coil: Air-cooled, aluminum fins bonded to copper tubes.

E. Accessories: Filter drier, high-pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).
   1. Provide thermostatic expansion valves.
F. Low Ambient Kit: Provide with ultra low ambient kit for operation down to -40 degrees Fahrenheit.
G. Operating Controls:
   1. Control by room thermostat to maintain room temperature setting.
   2. Low Ambient Kit: Provide refrigerant pressure switch to cycle condenser fan on when condenser refrigerant pressure is above 285 psig and off when pressure drops below 140 psig for operation to -40 degrees F.

2.5 ACCESSORY EQUIPMENT

A. Integral condensate pump capable of removing condensate to a remote drain location.
B. Room Thermostat: Wall-mounted, electric solid state microcomputer based room thermostat with remote sensor to maintain temperature setting; low-voltage; with following features:
   1. System selector switch (heat-off-cool) and fan control switch (auto-on).
   2. Automatic switching from heating to cooling.
   3. Preferential rate control to minimize overshoot and deviation from setpoint.
   4. Instant override of setpoint for continuous or timed period from one hour to 31 days.
   5. Short cycle protection.
   6. Selection features including degree F or degree C display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto.
   7. Battery replacement without program loss.
   8. Thermostat Display:
      a. Time of day.
      b. Actual room temperature.
      c. Programmed temperature.
      d. Programmed time.
      e. Duration of timed override.
      f. System Mode Indication: Heating (as applicable), Cooling, Fan Auto, Off, and On, Auto or On, Off.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.
B. Verify that proper power supply is available and in correct location.
C. Verify that proper fuel supply is available for connection.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.
B. Install in accordance with NFPA 90A and NFPA 90B.
C. Install refrigeration systems in accordance with ASHRAE Std 15.
D. Pipe drain from cooling coils to nearest floor drain.

END OF SECTION

SECTION 23 82 00 - CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Hydronic finned tube radiation.
B. Hydronic unit heaters.
C. Hydronic cabinet unit heaters.

1.2 REFERENCE STANDARDS

A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); Current Edition.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
   2. Indicate air coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
   3. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
C. Closeout Documents:
   1. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
   2. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
   3. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
   4. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
      a. See Section 01 60 00 - Product Requirements for additional provisions.

      b. Extra Filters: Two sets of each type and size.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 HYDRONIC FINNED TUBE RADIATION

A. Manufacturers:
   1. Modine Manufacturing Company: www.modineHVAC.com.
   2. Sterling Hydronics, a Mestek Company: www.sterlingheat.com.
   3. Vulcan Radiator, a Mestek Company: www.vulcanrad.com.
   4. Zehnder Rittling: www.rittling.com.
B. Required Directory Listing: AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); current edition at www.ahrinet.org.
C. Hydronic Heating Elements: 3/4 inch ID seamless copper tubing, mechanically expanded into evenly spaced aluminum fins sized for capacity indicated, suitable for soldered fittings. One or two row as

scheduled. the length of the finned element as scheduled shall be provided and not reduced in length based on the scheduled heating capacity.

D. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.

E. Enclosures: 18 gauge, 0.0478 inch sheet steel up to 18 inches in height, 16 gauge, 0.0598 inch sheet steel over 18 inches in height, with easily jointed components for wall to wall installation.

1. Mounting strips constructed of not less than 20 gauge steel shall support enclosure and position enclosure brackets.
2. Enclosure joints shall be made and accessories shall be installed without visible fasteners. They shall lock into the mounting strip and to adjacent cabinets or other components to insure a perfect fit without cutting
3. Enclosures shown short-of-wall installations shall have end panels.

F. Finish: Factory applied baked enamel of color as selected.

G. Access Doors: For otherwise inaccessible valves, provide factory-made permanently hinged access doors, 6 by 7 inch minimum size, integral with cabinet.

H. Fin radiation installed behind cabinet work shall be furnished less cover.

2.2 HYDRONIC UNIT HEATERS

A. Manufacturers:

1. Modine Manufacturing Company: www.modineHVAC.com/#sle.
2. Rittling. www.zehnder-rittling.com
3. Sterling Hydronics, a Mestek Company: www.sterlingheat.com.
4. Vulcan. www.vulcanrad.com
5. Trane Technologies, PLC: www.trane.com/#sle.
6. Daikin.

B. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.

C. Perform factory run test under normal operating conditions, water, and steam flow rates.

D. Casing: Minimum 18 gauge, 0.0478 inch thick sheet steel casing with threaded pipe connections for hanger rods for horizontal models and minimum 18 gauge, 0.0478 inch thick sheet steel top and bottom plates for vertical projection models.

E. Finish: Factory applied baked enamel of standard color as selected.

F. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.

G. Air Outlet: Adjustable pattern diffuser on vertical projection models and two way louvers on horizontal projection models.

2.3 HYDRONIC CABINET UNIT HEATERS

A. Manufacturers:

1. Modine Manufacturing Company: www.modineHVAC.com/#sle.
2. Rittling. www.zehnder-rittling.com
3. Sterling Hydronics a Mestek Company: www.sterlingheat.com.
4. Vulcan. www.vulcanrad.com
5. Trane Technologies, PLC: www.trane.com/#sle.

B. Coils:

1. Evenly spaced aluminum fins mechanically bonded to copper tubes.

C. Cabinet: Minimum 16 gage, 0.0598 inch thick sheet steel front panel with exposed corners and edges rounded, easily removed panels, glass fiber insulation, The inlet of any floor mounted units shall be a minimum of 4" above finished floor.. Unit shall be ceiling hung, recessed, semi-recessed, inverted flow, floor mounted or wall hung as scheduled. Recessed units shall be provided with 2" overlapping front cabinet on four sides for installation in wall above floor.

D. Finish: Factory applied baked enamel of color as selected on visible surfaces of enclosure or cabinet.

E. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.

F. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted with built-in thermal overload protection.

G. Control: Factory wired, solid state, infinite speed control, located in cabinet. Ceiling mounted units shall be provided with flush type speed control switch for remote wall mounting.

H. Filter: Easily removed, 1 inch thick glass fiber throw-away type, located to filter air before coil.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are suitable for installation.

3.2 INSTALLATION

A. Install in accordance with manufacturer's recommendations.

B. Finned Tube Radiation:

1. Locate on outside walls and run cover continuously wall-to-wall unless otherwise indicated.
2. Center elements under window with elements of equal length centered under each window for multiple windows.
3. Install wall angles and end caps where units butt against walls.
4. Align cabinet joints with window mullions.
5. Coordinate finned tube mounting height with architect and architectural elevations.

C. Unit Heaters:

1. Hang from building structure, with pipe hangers anchored to building, not from piping or electrical conduit.
2. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
3. If structure is more than six feet above unit, support off wall bracket or provide lateral bracing.
4. In wood construction, provide spring isolation hangers and flexible pipe connections.

D. Cabinet Unit Heaters:

1. Coordinate installation with architect.
2. Coordinate to ensure correct recess size for recessed units.

3.3 CLEANING

A. Vacuum clean coils and inside of units.

B. Touch-up marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.

END OF SECTION

SECTION 23 83 00 - RADIANT HEATING AND COOLING UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Hydronic radiant panel heaters.
B. Radiant heating hydronic piping.

1.2 REFERENCE STANDARDS

A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards; current edition.
B. ASHRAE Std 138 - Method of Testing for Rating Ceiling Panels for Sensible Heating and Cooling; 2021.
C. ASTM B75/B75M - Standard Specification for Seamless Copper Tube; 2020.
D. DIN 14037-2 - Free hanging heating and cooling surfaces for water with a temperature below 120 Degrees C - Part 2: Pre-fabricated ceiling mounted radiant panels for space heating - Test method for thermal output; 2016.
E. DIN 14037-3 - Ceiling Mounted Radiant Panels Supplied with Water at a Temperature Below 120 Degrees C; Part 3: Rating Method and Evaluation of Radiant Thermal Output; 2016.

1.3 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop drawings:
   1. Materials and layout.
   2. Manufacturer's Installation Instructions: Indicate installation instructions and recommendations.
C. Closeout Documents:
   1. Project Record Documents: Record actual locations of ceiling panel heaters.
   2. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions of equipment and controls, installation instructions, maintenance and repair data, and parts listings.
   3. Samples: The subcontractor shall submit a ceiling radiant panel sample to Architect for approval before installing any radiant ceilings.

PART 2 PRODUCTS

2.1 HYDRONIC RADIANT PANEL HEATERS

A. Manufacturers:
   1. Aero Tech
   2. Air Tex
   3. Airtite
   4. TWA
   5. Sigma
B. Linear Radiant Ceiling Panels: Heat sinks located behind panel, transfer heat between copper tubes and panel face, and radiate heat to zone.
   1. Linear Configuration:
      a. Frame type: Lay-in
      b. Size: see schedule
      c. Insulation: 3/4 lb. density glass fiber pads, Gustin-Bacon Ultralite 75, or equal
   2. Water Tubes:
      a. ASTM B75/B75M copper tubing, 1/2 inch minimum nominal diameter.

b. Water Connections:

1) Suitable for solder or compression fittings.

2) Protect with removable seals. Prevent introduction of dirt and dust during shipping.

3. Heat Sink Construction:
   a. Mechanically fasten extruded aluminum and copper pipe to heat sink.

   b. Provide non-hardening heat transfer paste between tubing, heat sink, and panel.

4. Panel Face: Construct of minimum 18 gauge, 0.0403 inch thick aluminum.
5. Finish:
   a. Color: As selected by architect from manufacturer's standard range.

   b. Maintain optimal radiative properties, durability, and cleanability.

6. Water Pressure Drop and Heating Output Data: Derive from factory testing in accordance with ASHRAE Std 138 or DIN 14037, Parts 2 and 3.

PART 3 EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION

A. Install in accordance with manufacturer's recommendations.
B. Hydronic Radiant Ceiling Panel Heaters:
   1. Install level and plumb.
   2. Suspend from structure.
   3. Support in grid-type suspended ceiling using grid as support element as follows:
      a. Install a minimum of four ceiling support system rods or wires for each panel, located not more than 6 inches from panel corners.

      b. Fasten support clips to panel and to ceiling grid members at or near each panel corner with clips designed for the application.

      c. Install at least one independent support rod or wire from structure to tab on panel with breaking strength of the weight of panel at a safety factor of 3.

   4. Unless otherwise indicated, install shutoff valve and union or flange at each connection.
   5. Circuiting of panels shall be such as to limit pressure loss across the individual controlled panel zone to 10 feet W.C., or less.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Hydronic Radiant Ceiling Panel Heaters:
   1. Inspect for damage to finish.
   2. Repair damaged finish to match original finish.
   3. Perform the following field tests, inspections, and prepare test reports:
      a. Leak Test:

         1) After installation, fill water tubes, and test for leaks.

         2) Repair leaks and retest until no leaks exist.

b. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.

c. Test and adjust controls and safeties.

4. Remove and replace damaged and malfunctioning controls and equipment and retest as specified above.

3.4 CLEANING

A. Radiant Ceiling Panel Heaters: Remove paint splatters, other spots, dirt, and debris.

1. Radiant Panels are prone to permanent staining from fingerprints. Contractor to ensure panel remains clean during installation and or degrease at final turnover.

END OF SECTION

SECTION 26 00 00 - ELECTRICAL GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical General Requirements specifically applicable to Division 26 Sections, in addition to Division 01 - General Requirements.

B. Definitions common to Division 26 specification sections.

1.2 RELATED DOCUMENTS

A. Drawings, addenda and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification Sections, apply to this and all other sections of Division 26.

B. This section is related to all other sections of Division 26.

1.3 DEFINITIONS

A. Words "Architect" where written in Division 26 specifications and drawings refer to commissioned Design Professional, whose name appears on contract documents.

B. Word "Engineer" where written in Division 26 specifications and drawings refers to Consulting Electrical Engineer, CMTA, Inc., 311 Fourth Street South, Suite #204, Grand Forks, ND, 58201; phone (701)775-2594.

C. Word "Contractor" where written in Division 26 specifications and drawings refers to Electrical Contractor and any and all of his subcontractors.

D. Word "Material" where written in Division 26 specifications and drawings shall mean any and all apparatus, equipment, devices, fixtures, components, products, assemblies, items, parts, things, and any other pieces specified or shown or required.

E. Word "Labor" where written in Division 26 specifications and drawings shall mean any and all physical effort, manpower, time, expertise, tools, equipment and services to carefully assemble, install and affix all material in a proper, complete and acceptable manner.

F. Word “Low Voltage” where written in Division 26 specifications and drawings shall mean 0 to 1,000 Volts (IEEE).

G. Word "Provide" where written in Division 26 specifications and drawings shall mean "Electrical Contractor shall furnish all labor and material and completely and properly install such material and leave same in acceptable condition and intended acceptable working order".

H. Performance Verification Testing refers to test performed in the field to ensure proper operation and / or installation of service or products.

1. Unless noted otherwise Performance Verification Testing is not required to be provided by a 3rd party testing firm.
2. Unless noted otherwise Performance Verification Testing is not required to be witnessed by the Electrical Engineer, Owner, Architect, and / or (if applicable) Commissioning Agent

I. Acceptance Testing refers to formal testing process required prior to acceptance by the Owner.

1. Unless noted otherwise Acceptance Testing is required to be provided by a 3rd party testing firm.
2. Unless noted otherwise Acceptance Testing is required to be witnessed by the Electrical Engineer, Owner, Architect, and / or (if applicable) Commissioning Agent.

J. As-built drawings are prepared by the contractor. They show, in red ink, on-site changes to the original construction documents.

K. Record drawings are prepared by the Architect or Engineer and reflect on-site changes the contractor noted in the as-built drawings.

L. Quality Assurance includes all the planned and systematic activities implemented that can be demonstrated to provide confidence that a product or service will fulfill requirements for quality. Typically, quality assurance procedures are performed before and while the work is being performed. As such in the Division 26 specifications Quality Assurance procedures are specified in Part 1.

M. Quality Control includes all the planned activities required to verify quality after the work has been performed. This can include testing and inspections along with other procedures. As such in the Division 26 specifications Quality Assurance procedures are specified in Part 3.

1.4 SCOPE OF WORK

A. All Specifications, corresponding Drawings and all Addenda form a complete set of documents for electrical work for this project, and no part shall be considered complete without the other.

B. The Specifications, Drawings, and all Addenda describe both the design characteristics and functional performance criteria that the completed electrical and telecommunications and electronic safety and security systems shall include.

C. Contractor shall obtain all required licenses, permits, plan reviews, inspections and pay all fees, costs and all other charges for this project. All sales, use and any other taxes shall be paid by Contractor.

D. Electrical Work shall comply with all ordinances, laws, regulations and codes applicable to the work involved. If, in any instance, the plans and specifications conflict with such laws, the stricter requirement shall take preference.

E. If Contractor is aware of conflicts between drawings or specifications and such codes or regulations, they shall be brought to the Engineer's attention prior to commencing work. If Contractor performs work in violation of such codes or regulations, Contractor shall correct the violation at his expense.

F. Work under Division 26 includes providing all labor and materials necessary for satisfactory completion of all electrical work shown on all drawings and in all specification divisions. In general, this consists of the following:

1. Luminaires and lighting control systems and devices.
2. Low Voltage Power Distribution.
3. Wiring devices.
4. Other systems specified, indicated, or shown.

G. Site Investigation

1. Prior to submitting bids, visit the work site to become familiar with existing conditions which may affect the cost of the project. This includes measurements for lengths, quantities, clearances and all other field verifiable conditions.
2. No extra charges will be allowed because of failure of Contractor to become familiar with all existing conditions.
3. Where work under this project requires extension, relocation, or modifications to existing equipment, systems or installations the existing equipment, system or installations shall be restored to their original condition, with exception to the work under this project, before completion.
4. Existing equipment, systems and installations which are not detailed on the drawings must still be restored to their original condition.

1.5 ALTERNATES

A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the Owner's option. Accepted Alternates will be identified in Owner-Contractor Agreement (contract).

B. Coordinate related work and modify surrounding work as required.

C. Schedule of Alternates: See Division 00 and Division 01.

1.6 DRAWINGS

A. Drawings indicate the extent and general layout of the electrical systems.

B. The electrical drawings are diagrammatic (that is, designed to demonstrate or explain the scope of work), they are intended to be as accurate as planning can determine.

C. The scales are shown for estimating purposes only. Field verification of dimensions, locations, and construction details is required. Review appropriate drawings (for example: shop drawings), make field measurements and adjust work to suit the conditions encountered. Although electrical drawings are diagrammatic, they shall be followed as closely as actual construction permits.

D. Contractor shall coordinate with civil, architectural, structural, and mechanical construction drawings for locations of partitions, walls, beams, shafts, equipment, etc.

E. **DO NOT SCALE LOCATIONS OF ELECTRICAL OUTLETS, LIGHT FIXTURES, OR OTHER DEVICES FROM ELECTRICAL DRAWINGS**.

F. Standard electrical symbols along with special symbols are used on all drawings.

1.7 REGULATORY REQUIREMENTS

A. Work provided shall comply with the following partial list of governing codes and regulations:

1. International Building Code (IBC).
2. International Fire Code. (IFC).
3. State Fire Codes.
4. State and Local Electric Codes.
5. State Building Code.
6. Serving Utility Regulations.
7. National Fire Protection Association (NFPA) National Fire Codes.
   a. NFPA 70 - National Electrical Code.
   b. NFPA 72 - National Fire Alarm and Signaling Code.
   c. NFPA 101 - Life Safety Code.
8. Williams-Steiger (OSHA) Regulations.
9. Americans with Disabilities Act (ADA) requirements.
10. State Health Department Requirements
11. Bureau of Indian Affairs

1.8 QUALITY ASSURANCE

A. Notify the Architect or Engineer of any discrepancies in or omissions from the drawings and documents. Interpretations and clarifications during bidding will be made only by written Addenda. If discrepancies are not reported, the contractor shall bid the greater quantity or better quality, and appropriate adjustment will be made after contract award.

B. Any work not clear to Contractor shall be referred to Architect or Engineer for clarification before bid is submitted. If no question is raised prior to opening of bid, Contractor shall be required to provide work, in question, as directed by Architect or Engineer, whose decision shall be final, without additional charges.

C. By virtue of submitting a bid, Contractor agrees that he is skilled and experienced in use of and in interpretation of drawings and specifications. Contractor further agrees that he has carefully reviewed all drawings, all specifications and all addenda, which constitute bid documents for this contract, and finds them free of ambiguities and good and sufficient for bidding and construction purposes.

D. Should major changes from drawings and specification be necessary, Contractor shall provide notification and secure written approval and agreement concerning such changes before work is started.

1.9 WARRANTY

A. The Electrical Contractor shall guarantee that all materials and equipment included in their work free of defects caused by flawed workmanship, material or equipment failures.

B. The warranty guarantee shall extend one year minimum from the date of final acceptance of the work or for as long as normal equipment manufacturer warranties are in effect from the date of final acceptance of the work.

C. During the warranty period, the Electrical Contractor shall respond by making appropriate corrections or repairs required to correct defect within one week of notification. Notification shall be made by telephone, fax, email, or letter.

D. The Electrical Contractor shall provide 24-hour service in case of emergency.

1.10 SUBSTITUTIONS

A. Where substitute materials or prior approved materials are provided, Contractor shall assume all responsibility and pay for all necessary changes resulting from such substitution. This responsibility shall also include any extra costs required by other trades.

B. Required where specifically noted or where materials are specifically identified by a manufacturer's name, model or catalog number. In these cases only such material may be included in base bid. Prior approval of substitute materials shall be required.

C. Prior approved substitutions:

1. Requests for prior approval shall be made in accordance with Division 01, as specified below, and indicated in specific specification section.
2. If Contractor desires to furnish materials other than that named, Contractor or supplier shall apply in writing, to Architect, for prior approval of such material at least ten (10) days prior to bid opening date.
3. Requests for prior approved substitution shall indicate specific proposed materials in lieu of those specified together with complete technical data for all such proposed material.
4. All prior approved substitutions will be clearly identified in addenda which will be sent to all bidders well in advance of bid opening. Only material listed on drawings, specifications and addenda shall be provided.

D. Substitutions after execution of contract: Substitution of materials other than those specifically named in contract documents will be approved, by Architect or Engineer, for following reason only:

1. That material proposed for substitution is equal to or superior, in Engineer and Architect's opinion, to that specified in construction, efficiency, appearance, and utility.
2. That material named in the documents cannot be delivered to project in time to complete work due to conditions beyond control of Contractor.

E. Equal To and Or Equal: Where materials are specifically identified as “equal to” an identified manufacturer’s name, model, or catalogue numbers or where noted as “or equal” manufacturer’s complying with the requirements of these specifications not listed may be incorporated in the Work. Such materials must be equal to or superior, in Engineer’s opinion, to that specified in construction, efficiency, appearance, and utility.

1.11 GENERAL REQUIREMENTS FOR SUBMITTALS

A. Submit according to the requirements of Division 01.

B. General requirements for Submittals for Review

1. Submittal format, general information, and requirements for all submittals:
   a. At the front of the submittal on a dedicated page(s): name, address, and phone number of equipment vendor, engineer, and contractor.

   b. At the front of the submittal on dedicated page(s): Any deviation from contract requirements shall be called to attention. No deviation will be permitted without written approval of Architect or Engineer.

   c. At the front of the submittal on dedicated page(s): Any requests for clarification, selections that must be made, etc. shall be called to attention.

   d. At the front of the submittal on a dedicated page(s): Include a complete list of equipment included with manufacturer and model number or catalog number.

   e. Submittals shall be grouped to include complete information for related systems, products, and accessories in a single submittal with tabs, dividers, or other means of separating each different component within the submittal from the next.

   f. Mark dimensions and values in units to match those specified.

g. Drawings and brochures shall be clearly marked as to item to be supplied and shall have designation corresponding to designation on Drawings (for example: enclosed switch data shall indicate for which equipment they are provided).

2. Contractor Review of Submittals
   a. The Contractor shall thoroughly review each item for compliance with these Specifications making any necessary corrections prior to issuing submittal. Each submittal set shall be stamped, signed and dated indicating Contractor review. If the Contractor fails to properly review submittals, the Contractor shall reimburse the Engineer for all additional reviews on a time and material basis.

   b. Should the contractor fail to comply with any of the requirements of the specified submittal requirements; then the right is reserved by the Architect or Engineer to select any or all items in the material schedule, with that selection to be final and binding upon the contractor. The materials selected or reviewed, as the case may be, by the Architect and / or Engineer, shall be used in the work at no additional cost to the Owner.

3. Architect / Engineer Review of Submittals
   a. The submittal will be reviewed with reasonable promptness, and returned to the Contractor (with copies retained by the Engineer and the Architect). No equipment should be released for shipment until submittals have been approved.

   b. Submittal review is to verify general conformance with the design concept of the Project and substantial compliance with the information provided in the Contract Documents. This review does not in any way relieve the Contractor or their suppliers of their responsibility to provide all materials and equipment as specified, in quantities, quality and dimensions required.

   c. Approval Stamp: Submittals will be reviewed with the following actions noted:

      1) “No Exception Taken” indicates that the Submittal appears to conform to the design concept of the Work and that the Contractor, at his discretion, may proceed with fabrication and/or procurement and installation.

      2) “Reviewed as Noted” indicates that the Submittal, after noted corrections are made, appears to conform to the design concept of the Work and that the Contractor, at his discretion, may proceed with fabrication and/or procurement and installation, if the corrections are accepted by the Contractor without an increase in Contract Sum or Time.

      3) “Revise and Resubmit” indicates that the noted revisions are such that a corrected copy of the Submittal is required for review to confirm that the noted revisions have been understood and made. The Contractor, at his discretion, may proceed with fabrication and/or procurement and installation after submitting a corrected copy and verifying with the reviewer that the corrected copy is acceptable, if the corrections are accepted by the Contractor without an increase in the Contract Sum or Time.

      4) “Rejected” indicates that the Submittal does not appear to conform to the specifications, a resubmission is required and fabrication or procurement is not authorized.

4. If the Architect or Engineer rejects (Revise and Resubmit or Rejected) the same section two times the engineer shall be compensated for additional reviews (beyond the first two) at a rate of $500 per review. Compensation will be incorporated by Change Order and will be deducted from the Contractor's application for payment. Contractor is responsible for all delays caused by the resubmittal process

C. General Requirements for Submittals For Information
   1. Information submittals shall include the information noted in the specifications and information requested by the Architect, Engineer, and / or Owner.
   2. Coordination Drawings: Where this and other specification sections require Coordination Drawings to be submitted meet the requirements defined in Division 01 and as indicated below.
      a. Prepare documents using software program required by Division 01. If no requirements are listed utilize a software compatible with AutoDesk's AutoCAD.
      b. Submit hardcopies and / or electronic copies as required by Division 01. Drawings and files shall be uniquely labeled.
      c. Scale shall not be less than 1/8" equal 1 foot.

D. General Requirements for Submittals for Closeout:
   1. As specified in Division 01 and Section 26 0100.

E. General Requirements for Product Data. The following are minimum requirements.
   1. Catalog sheets showing ratings, settings, performance curves and rated capacities.
   2. Dimensions, knockout sizes and locations, materials, fabrication details, finish.
   3. Outline and support point dimensions, voltage, ampacity, integrated short circuit ampere rating, arrangement and sizes, roughing-in data, and accessories.
   4. Operational Characteristics.

F. General Requirements for Shop Drawings. The following are minimum requirements.
   1. Electrical ratings of equipment; how the components of the equipment are assembled and function together; and how they will be installed on the project.
   2. Dimensioned plans, elevations, sections, and details. Show quantities of installed devices, features, and ratings.
   3. Detail enclosure types.
   4. Detail configuration, current, and voltage ratings.
   5. Detail features, characteristics, ratings, and factory settings devices and auxiliary components.
   6. Include wiring diagrams for power, signal, and control wiring.

G. General Requirements for Manufacturer's Instructions. The following are minimum requirements.
   1. Application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements.
   2. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
   3. Instructions for placing each piece of equipment and system into operation.

1.12 **PROJECT SUBCONTRACTOR AND VALUES LISTING**

A. Contractor shall submit, to Architect, a list indicating brands of all major materials, names of all of his subcontractors and a schedule of values for this project. Engineer reserves right to reject any material or subcontractor and question scheduled values.

PART 2 PRODUCTS

2.1 Not Used.

PART 3 EXECUTION

3.1 Not Used.

END OF SECTION

SECTION 26 00 11 - BASIC MATERIAL AND METHODS

PART 1 GENERAL

1.1 CONDITIONS OF THE CONTRACT

A. The Conditions of the Construction Contract and applicable provisions of Division l - General Requirements, as well as these General Provisions, shall apply to all of Division 26, 27 and 28.

B. All installations shall meet all Local, State and National Codes.

1.2 DEFINITIONS

A. Furnish: Under this Contract, Contractor shall deliver to the site item(s) specified, as well as additional specialized materials and/or accessories necessary for the use and operation of item or items specified.

B. Install: Under this Contract, Contractor shall set in position, connect (including sub-assemblies furnished), and adjust for use. Contractor shall furnish miscellaneous specialty items such as fittings, hangers, fastening devices, etc., as obviously necessary for a complete and operating installation.

C. Provide: Under this Contract, Contractor shall furnish and install item or items specified. Contractor shall perform all labor and furnish all materials and equipment necessary to that specified item or system will be complete and operational in every respect.

1.3 **DRAWINGS**

A. In general, the drawings of the Electrical Systems and Equipment are to scale, however, to determine exact locations of walls and partitions, the Contractor shall consult the Architectural and/or Structural Drawings which are dimensioned. Drawings shall not take precedence over field measurements. Plans showing circuiting or conduit routing, although shown on scale drawings, are diagrammatic only. They are intended to indicate the size and/or capacity where stipulated, approximate location and/or direction, and approximate general arrangement of one phase of work to another, but not the exact detail or exact arrangement of construction.

B. If it is found before installation of any or all construction phases, that a more convenient, suitable or workable arrangement of any or all phases of the project would result by varying or altering the arrangement indicated on the drawings, the Engineer may require any or all Contractors to change the location or arrangement of their work without additional cost to the Owner. Such rearrangement shall be in accordance with directions from the Engineer.

C. Where discrepancies are discovered after certain portions or phases of any Contract have been installed, the Engineer reserves the right to have the Contractor make minor changes in conduit or duct, outlet, fixture or equipment locations or arrangements to avoid conflict with other work at no additional cost to the Owner. It shall be the responsibility of the contractor to provide written notification to the Engineer prior to making any changes or performing any additional work described in the plans and specifications. The Contractor may not be compensated for work done before notifying the Engineer.

D. Because the drawings are to a relatively small scale to show as large a portion as is practical, the fact that only certain features of the system are indicated does not mean that other similar or different features or details will not be required. The Contractor shall furnish all incidental labor, materials, or equipment for the systems under their control, so that each system is a complete and operating one unless otherwise specifically stipulated in the detailed body of the Specifications.

E. The Contractor shall be responsible for determining all field measurements before commencing construction, giving due consideration to building design and other equipment to be installed. Electrical equipment not dimensioned on the drawings shall be field located, giving due consideration to the work of other trades. The Contractor shall verify all dimensions before proceeding with the work. Where cutting and patching is required, each Subcontractor shall be responsible for their own work, unless otherwise determined by the Contractor.

F. Dimensions shall not be scaled from the drawings. If the Contractor discovers any discrepancy between actual measurements and those shown on the drawings which prevents good practice, good arrangement,

or which is contrary to the intent of the drawings and specifications, he shall notify the Engineer before proceeding with the work.

1.4 SITE INSPECTION

A. Before submitting a proposal for the Work contemplated in these specifications and accompanying drawings, each bidder shall examine the site and familiarize himself with all the existing conditions and limitations, including the extent of demolition, cutting and patching to be done by the Subcontractor for Electrical Work. No extras will be allowed because of the Contractor's misunderstanding as to the amount of work involved, or their lack of knowledge of any condition in connection with the Work.

1.5 PRODUCT/ASSEMBLY/SYSTEM SUBSTITUTIONS

A. Where the Bid Documents stipulate a particular Product, substitutions will be considered by the Engineer up to 7 days before receipt of bids.

B. When a request to substitute a Product is made, the Engineer may approve the substitution and will issue an Addendum to known bidders.

C. The submission shall provide sufficient information to determine acceptability of such products.

D. Provide Products as specified unless substitutions are submitted in this manner and subsequently accepted.

E. The cost of any changes of other trades as a result of use of the substitution material or equipment must be borne by the Subcontractor submitting such material or equipment.

F. Fax or telephone requests for substitution will not be accepted.

G. Those vendors wishing written approval shall include a return copy and a self-addressed stamped envelope with their request.

H. The listing of any manufacturer as "acceptable" does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any price quotations received and submittals made are for equipment which meet or exceed the specifications included herein.

I. When a product is considered discontinued by the manufacturer, an equal or better product shall be used instead of the discontinued product, pending engineering approval.

1.6 EQUIPMENT

A. All equipment shall be new and in first-class condition. Equipment shall not be used for purposes other than intended by the manufacturer.

B. Manufacturer's nameplate, name or trademark shall be permanently affixed to all equipment and material furnished under this Specification. Nameplate of Subcontractor or distributor will not be acceptable. Nameplate shall be masked prior to any painting. Remove masking after completion.

C. Equipment specified and furnished shall be of a type and manufacturer that has a local representative and a local replacement and service outlet to give complete coverage on parts and service at all times.

1.7 WARRANTY

A. The Contractor shall be held responsible for any and all defects in equipment and workmanship which appear for one (1) full year after the date of Substantial Completion. All such defects must be repaired or defective equipment promptly replaced by the Contractor at no expense to the Owner.

1.8 INSPECTIONS AND FEES

A. The Contractor shall obtain all permits and licenses required in connection with the work under Division 26, 27 and 28. Cost for such shall be paid by the Contractor.

B. When application for utility service is the Owner's responsibility, the Contractor shall be responsible for all phases of the installation other than the application itself and shall coordinate the utility's work with their installation.

1.9 SUBMITTALS

A. Drawing Plan Backgrounds Available

1. Electronic drawing files may be available to the contractor for the purpose of preparing shop drawings or submittals. Files provided by the Engineer are generally available at a nominal fee of $100 per drawing file. Drawings requiring extensive modification for retransmital will have an additional time and material charge for labor or expenses incurred.

B. List of Suppliers & Subcontractors:

1. The Contractor shall submit a list of suppliers, Subcontractors, and manufacturers for equipment installed under Division 26, 27 and 28 for approval. Contractor shall make such submittal within 16 days after Notice to Proceed, prior to ordering any equipment. Approval of such list does not relieve the Contractor from submittal of shop drawings, nor shall it constitute final approval should the shop drawings be found not in agreement with the Specifications.
2. If a list of materials is not submitted, it shall be assumed that the Contractor has waived their option of equipment selection in favor of selection by the Engineer.

C. Cost Breakdown:

1. Before submittal of the first Request for Payment, the Contractor shall submit to the Engineer, an itemized cost breakdown, including separation of labor and material, for work under Division 26, 27 and 28. The breakdown shall be divided in such detail as requested to aid in approval of Payment Requests based on work completed. Breakdown shall include, but not be limited to:
   a. Special Electrical Conditions (Bonds, Fees, Mobilization, etc.)
   b. Conduit, boxes, wire, etc.
   c. Panelboards, Switchboard, circuit breakers and disconnects.
   d. Devices
   e. Luminaires
   f. Lighting Controls
   g. Telephone/Data
   h. Fire Alarm System
   i. Paging System

D. Shop Drawings:

1. See Division 1 for submittals procedures. This section supplements the requirements of Division 1. In case of differences, the greater requirement applies.
2. Shop drawings shall be submitted for all major equipment under each Section of this Specification.
3. Shop drawings must first be checked by the Contractor for capacities and space conformance, and so stamped prior to submittal to the Engineer.
4. Submit the signed and stamped electronic drawings or a minimum of eight (8) copies of paper shop drawings.

E. Operating and Maintenance Manuals:

1. The Contractor shall prepare a single bookmarked PDF portfolio of all Electrical equipment furnished by him on the project. These portfolios shall include manufacturer's shop drawings, parts' lists, warranty information including dates, and operating and maintenance instructions of such equipment. Information shall be bookmarked by related specification section and by device/product used. Upon completion of this PDF portfolio, the Contractor shall make a copy available to the Engineer via a file-sharing service for final approval. Once approved, the PDF file shall be delivered to the owner on a new USB flash drive purchased for this purpose.
2. Refer to Division 01 for any additional submittal requirements for these manuals.

3. Instructions shall include the following information:
   a. Manufacturer's recommended cleaning and maintenance procedures.
   b. List of materials recommended for maintenance.
   c. Complete operating instructions.
   d. Name and address of authorized service organization and parts depot.
4. Where indicated in the Specifications, the Contractor shall provide the services of a factory trained representative to instruct the Owner's authorized personnel in the operation, control and maintenance of equipment.

F. Record Drawings:
1. The Contractor shall keep a complete set of all Electrical drawings in their job site office for purposes of showing "As-Built" installation of Electrical systems and equipment.
2. This set of drawings shall be used for no other purpose. Where any material, equipment or system components are installed different from that shown on the Drawings, such differences shall be clearly and neatly shown on this set of drawings using ink, or indelible pencil. The change notations shall be kept up-to-date on a daily basis. This set of drawings shall be transmitted to the Engineer as directed, and after the Engineer has examined the drawings, the set will be returned to the Contractor for further use. At the completion of the project, the set of drawings shall be turned over to the Engineer for approval and delivery to the Owner.

1.10 ELECTRICAL SERVICE INTERRUPTIONS

A. Proposed outage schedules shall be scheduled at the earliest possible date. Approximate lengths and periods of time for outages shall be indicated along with a sequence of the work. All power outages (including individual panelboards) shall be coordinated with Owner .

PART 2 - PRODUCTS - NOT USED.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. Workmanship shall be first-class in every respect. Standard accepted practice in the various trades shall be considered as minimum. The Engineer reserves the right to reject any workmanship not in accordance with the specifications, either before or after installation of equipment.

3.2 COORDINATION

A. The Contractor shall coordinate locations and arrangements of their equipment with other Contractors and Subcontractors working on the project. Before starting work, the Contractor shall examine the Architectural, Structural and Electrical drawings and specifications, as well as shop and vendor drawings, for all divisions, to ascertain locations, levels, arrangements and dimensions of other work and shall confer and cooperate with all other Contractors or Subcontractors to avoid all interferences. They shall also provide Subcontractors for other trades with information regarding locations, arrangements and dimensions of their equipment. They shall also coordinate their own cutting and patching requirements with those of other Subcontractors, so that it will not be necessary for any Subcontractor to remove or re-do work improperly scheduled.

B. In cases of interferences between various items of equipment or between equipment and building members, if simplified construction is made possible by the relocation of certain equipment, changes in arrangements may be made, but only if authorized by the A/E.

C. Interferences between the work of different divisions which cannot be resolved by the parties involved shall be submitted to the Engineer who shall decide upon final location and arrangement without respect to which work was installed first.

3.3 JOB INSPECTION

A. Periodic job site observations will be made throughout the construction to review applications for payment, observe methods and materials of construction, and review requirements of the Bid Documents.

B. Contractor shall notify the Engineer, or authority having jurisdiction, and arrange for observation of installation prior to backfill or concealing of systems. Contractor shall, to the maximum practical extent, schedule work to allow for the observation of systems' installation in groups rather than individually.

C. Upon completion of all work, and submittal and approval of Test Reports, Maintenance Manuals and Record Drawings, Contractor shall notify the A/E and shall make arrangements for a Substantial Completion inspection.

D. After the inspection is made, the Contractor will receive a list of items requiring adjustment, correction, replacement or completion.

E. The Contractor shall promptly comply completely with all the listed requirements. Should the Contractor fail to perform promptly, the Engineer reserves the right to have the work completed by others and the cost deducted from the contract price.

F. The Contractor will be billed for projects which are not complete enough for a Substantial Completion Report (Punch List) by the Engineer when one is previously scheduled.

3.4 INSTRUCTION

A. Complete operating instructions composed of charts, diagrams, installation instructions, service instructions and wiring diagrams, shall be mounted in a conspicuous location on or immediately adjacent to the equipment concerned. Charts shall be in a glass or approved plastic-enclosed case.

B. Contractor shall instruct the Owner's personnel in the operation and maintenance procedures of all equipment and systems. Contractor shall confirm in writing prior to the final inspection that Owner has been instructed to their satisfaction in the operation of all systems. Coordinate with the Owner.

C. The Contractor shall obtain and maintain a list of all attendee in attendance at all training sessions. This list shall be submitted to the Engineer.

D. Additional requirements shall be listed in some sections of this specification.

3.5 ENERGIZED EQUIPMENT

A. Electrical Equipment that is energized shall not be worked on in the energized state.

END OF SECTION

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SECTION 26 01 00 - ELECTRICAL SYSTEMS CLOSE OUT DOCUMENTATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Operations and Maintenance Manuals.
B. Warranty Documentation.
C. Maintenance Materials.
D. As-Built Drawings.

1.2 RELATED DOCUMENTS

A. Drawings, addenda and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification Sections, apply to this and all other sections of Division 26.
B. This section is related to all other sections of Division 26.

1.3 SUBMITTALS FOR REVIEW

A. Submit under provisions of Division 01 and Section - Electrical General Requirements.
B. Provide operations and maintenance manuals and As-Built drawings.

1.4 SUBMITTALS FOR CLOSEOUT

A. Provide all documents as described below and in each specification section according to the requirements of Division 01 upon reaching substantial completion of the project unless noted otherwise.

PART 2 PRODUCTS

2.1 OPERATIONS AND MAINTENANCE MANUALS

A. Provide operations and maintenance manual for electrical system as a bookmarked PDF on a USB flash drive. Refer to Division 01 for additional requirements.
B. Provide dedicated manuals for the following:
    1. Division 26 systems and equipment unless noted otherwise.
    2. Division 26 lighting and lighting control.
C. Common Results for Operation and Maintenance Manuals. The following information shall apply to all manuals.
    1. Provide a master index at the beginning of manual indicating items included.
    2. The first section of each manual shall list the name, address, and phone number of Architect, Electrical Engineer, Contractor, and all associated Subcontractors.
    3. Each section shall include an approved and edited copy of submittals for review with review comments.
    4. Warranty information shall be provided with each piece and / or type of equipment include Manufacturer’s Warranty Statement.
    5. Testing Reports shall comply with the requirements of section - Testing of Electrical Systems.
    6. Each section shall be digitally bookmarked with the section title as listed below, and each device/cutsheet shall be bookmarked with the device type/name.
D. The Division 26 systems and equipment manual shall include the following sections. See the applicable sections of the Division 26 specifications for additional information.
    1. Switchboards.
    2. Distribution Panelboards.
    3. Branch Circuit Panelboards.
    4. Enclosed Switches and Circuit Breakers.
    5. Shunt Trip Elevator Switch.
    6. Protective device coordination study.

7. Wiring devices.
8. Surge protective devices.
9. Owner Training / Demonstrations.
10. Test Reports and Certificates.
11. Operation and Maintenance Guidelines.
12. Contractor's Warranty Statement according to the requirements of specification "Electrical General Requirements."

E. The Division 26 Lighting and lighting control manual shall include the following sections. See the applicable sections of the Division 26 specifications for additional information.

1. Luminaires (including specific lamp and ballast information).
2. Lighting control devices.
3. Lighting control systems. Include electronic copies of final system programming.
4. Owner Training / Demonstrations.
5. Test Reports and Certificates.
6. Operation and Maintenance Guidelines.
7. Contractor's Warranty Statement according to the requirements of specification "Electrical General Requirements."

2.2 AS-BUILT DRAWINGS

A. The contractor shall maintain one set of drawings at the job site to be used as a master copy. All changes and deviations shall be clearly marked and noted by colored pencil. These drawings shall be turned over to the Architect upon project completion.

B. As-Built Drawings shall include the following information in addition to specific information indicated in individual specification sections:

1. Actual locations / configurations of components and circuits.
2. Indication of route of all feeders and branch circuits 100-amps and larger.
3. Indicate route and location of all underground circuits, raceways, pull boxes, etc.
4. Indicate actual locations and mounting heights of outlet boxes, pull boxes, junction boxes, surface metal raceway, and wireway.
5. Final locations of all lighting control devices and diagrams showing circuiting / control wiring arrangements.
6. Provide table indicating final setting of all automatic lighting control sensors.
7. Provide document indicating final programming of relay panel.
8. Panel and Switchboard Directories: Provide revised typed directories with As-Built documents.
9. If aluminum conductors are installed as allowed by Section - Low Voltage Electrical Conductors and Cables, the As-Built drawings shall indicate which feeders / branch circuits are aluminum and a revised typed feeder / branch circuit schedule shall be provided indicating conductor and conduit sizes.

C. Indicate other information specifically noted in other Division 26 specification sections.

2.3 MAINTENANCE MATERIALS

A. Turn over to owner and obtain signed receipt for all maintenance materials, spare parts, touched up parts and loose items.

PART 3 EXECUTION

3.1 Not Used.

END OF SECTION

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This Section includes limited scope general construction materials and methods for application with electrical, communications, and electronic safety and security systems installations.

B. Materials specified herein include:

1. Concrete.
2. Miscellaneous for support of electrical materials and equipment.
3. Hangers and Supports.
4. Joint sealers for sealing around electrical materials and equipment; and for sealing penetrations in walls, floors, ceilings, roofs, foundations for moisture, water, smoke, fire and acoustic control.

C. General electric construction methods and requirements specified herein include:

1. Material and workmanship.
2. Product manufacturer requirements.
3. Coordination.
4. Safety.
5. Material handling, storage protection, cleaning and painting.
6. Cutting, patching and finishing.
7. Penetrations.
8. Wiring Methods.
9. Balancing Loads.
10. System Interruptions.
11. Outlet mounting heights.
12. Electrical demolition and remodeling.
13. Equipment Wiring (connections).

D. Owner Instruction and Demonstration.

1.2 RELATED DOCUMENTS

A. Drawings, addenda and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification Sections, apply to this and all other sections of Division 26.

B. This section is related to all other sections of Division 26.

C. Division 03 Section Cast-in-Place Concrete (Miscellaneous Cast-in-Place Concrete).

D. Division 03 Section Grouting.

E. Division 03 Section Concrete Boring (Concrete Core Drilling).

F. Section 26 01 00 Electrical Systems Close Out Documentation.

1.3 ELECTRIC SERVICE DESCRIPTION

A. Serving Utility Company: Valley City Public Works

B. System Characteristics: As indicated on drawings.

1.4 REGULATORY REQUIREMENTS

A. See Section 26 0000.

1.5 COMMON REQUIREMENTS FOR QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years experience.

B. Installer Qualifications: Engage experienced Installers for Work.

C. 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 re-certification.

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

E. Standardization of Product Manufacturer:
   1. When two or more items of same material or equipment are required they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, wire, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in Work, except as otherwise indicated.
   2. Except as noted, all switchboard, panelboards, safety switches, and equipment or wiring cabinets shall be manufactured by the same company, all finishes shall be the same color, and all equipment shall fit the space designated.
   3. Except as noted, all magnetic starters, manual starters and motor control centers shall be manufactured by the same company, all finishes shall be the same color, and all equipment shall fit the space designated.
   4. Wiring devices and other items covered under a single specification section, with the exception of light fixtures, shall be of the same manufacturer and style whenever practical or where failure to do so is visibly noticeable.

F. Material and Workmanship:
   1. All materials provided shall be new and shall be approved by the Underwriters Laboratories, Inc., NFPA, NEMA, and ANSI as conforming to its standards in every case where such a standard has been established for such material.
   2. Materials shall be standard products of manufacturer’s regularly engaged in the production of such equipment and shall be the manufacturer’s latest standard design.
   3. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
   4. All workmanship shall be neat and complete in both effectiveness and appearance and shall be executed by persons licensed and skilled in the trade. Engineer reserves the right to reject any material or workmanship before, during or after construction.
   5. Materials and Finishes: Provide adequate corrosion resistance to eliminate staining of exposed surfaces.
   6. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.

G. Coordination:
   1. See also “Quality Assurance” paragraph of Section 26 0000.
   2. Discrepancies and omissions discovered during construction shall immediately be called to the attention of the Architect or Engineer for clarification.
   3. Installation of materials shall be coordinated with other trades and installed at such time and manner as to not delay or interfere with the work of other trades.
   4. Obtain and review shop drawings, product data, manufacturer’s wiring diagrams, and manufacturer's instructions for equipment furnished under other sections. Determine connection locations and requirements.
   5. Sequence and coordinate work with other trades so as to avoid conflict of space and time sequence. If interference develops, the matter shall be brought to the attention of the Architect for decision.
   6. Organize the work so that progress of work will conform to the progress of other trades. Give particular attention to large equipment requiring positioning prior to closing the building.
   7. Complete the entire installation as soon as building conditions permit.
   8. This Contractor shall be held solely responsible for coordinating proper size and location of hangers, slots, chases, openings, etc., required for proper installation of his work and shall arrange with the proper building contractors for inserts, chases, and openings.

9. Refer to drawings and specifications of all other divisions and trades for correlating information, location and details of work, dimensions, etc. Coordinate location of all outlets and equipment. If conflicts develop Architect or Engineer's decision will govern. No additional compensation will be allowed for moving of un-coordinated, misplaced or poorly located outlets, material, equipment or work.

H. Pre-installation meetings are required as noted in this and other specification sections and are intended to help coordination efforts. Electrical Contractor shall schedule and convene a pre-installation meeting with all affected trades as noted in specifications and on Drawings.

I. Provide competent representative(s) on site constantly to supervise work from beginning through completion and final acceptance. So far as possible contractor shall keep same foreman and workmen throughout project duration.

J. During its progress, the work shall be subject to observation by representatives of Owner, Architect and Engineer at which times Contractor shall furnish all required information and cooperation

1.6 **SAFETY**

A. Comply with the requirements of Division 01 and this specification.

B. Perform work in accordance with NFPA 70E and in compliance with OSHA requirements.

C. Do not perform work on exposed live electrical equipment. If work is required (as defined by OSHA 29 CFR 1910.333) to be performed on exposed live electrical equipment an energized work permit must be must be prepared (see NFPA 70E for energized work permit requirements) and a Hazard/Risk Analysis in accordance with NFPA 70E and provide appropriate levels of personal protective equipment according to NFPA 70E.

D. Only Qualified Persons as defined by NFPA 70E shall be allowed to work on exposed live electrical equipment. Observe the safety boundaries defined in NFPA 70E.

E. Prior to performing work on exposed live electrical equipment convene a safety meeting to address safety hazards specific to the task.

F. Safety Program: the electrical contractor shall implement and document an electrical safety program in accordance with NFPA 70E and a workplace safety program that complies with the requirements OSHA and NFPA 70E.

PART 2 PRODUCTS

2.1 **HANGERS AND SUPPORTS**

A. Anchors and Fasteners:

1. Manufacturers
   a. RACO.
   b. Appelton
   c. Caddy
   d. B-Line
   e. Substitutions: Under provisions of Division 01 and Section - Electrical General Requirements.

2. Concrete Structural Elements: Use precast insert system, expansion anchors, powder actuated anchors and preset inserts.
3. Steel Structural Elements: Use beam clamps, spring steel clips, steel ramset fasteners, and welded fasteners.
4. Concrete Surfaces: Use self-drilling anchors and expansion anchors.
5. Hollow Masonry and Gypsum Board Partitions: Use toggle bolts and hollow wall fasteners.
6. Solid Masonry Walls: Use expansion anchors and preset inserts.

7. Sheet Metal: Use sheet metal screws.
8. Wood Elements: Use wood screws.

B. Steel Channel:

1. Manufacturers:
   a. B-Line Systems, Inc.
   b. Unistrut ®.
   c. Substitutions: Under provisions of Division 01 and Section - Electrical General Requirements.
2. Description:
   a. Hot dip galvanized where located outdoors and in wet/damp locations.
   b. Painted steel indoors in dry locations.
   c. Paint cut ends of channel in damp locations.
   d. Stainless steel or nonmetallic channel as shown on plans.

C. Powder Activated Anchors: Remington. Substitutions: Under provisions of Division 01 and Section - Electrical General Requirements.

D. Spring Steel Clips:

1. Caddy
2. Steel City
3. Substitutions: Under provisions of Division 01 and Section - Electrical General Requirements

E. Miscellaneous Metals:

1. Steel plates, shapes, bars, and bar grating: ASTM A 36.
2. Cold-Formed Steel Tubing: ASTM A 500.
3. Hot-Rolled Steel Tubing: ASTM A 501.
4. Steel Pipe: ASTM A 53, Schedule 40, welded.
5. Nonshrink, Nonmetallic Grout: Premixed, factory-packed, nonstaining, noncorrosive, nongaseous grout, recommended for interior and exterior applications.
6. Fasteners: Zinc-coated, type, grade, and class as required.

F. Miscellaneous Lumber:

1. 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 that 19 percent.
2. Construction Panels: Plywood backboards; APA A-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 3/4 inches.

2.2 JOINT SEALERS

A. General: Joint sealers, joint fill material, and other related materials compatible with each other and with joint substrates under conditions of service and application.

B. Colors: As selected by the Project engineer from manufacturer's standard colors.

C. Provide fire resistant joint sealers as specified in Division 07.

D. Fire-Resistant Joint Sealers: One-part or two-part, foamed-in-place, sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes, ducts and through penetrations through fire-rated walls, ceilings, roofs and floors. Sealants and accessories shall have required fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

2.3 **SLEEVES**

A. Sleeves for Raceways and Cables
   1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized Steel.
   2. Rectangular Sleeves: Galvanized Sheet Steel. 16 Gauge for less than 50 square inches and not side longer than 16 inches. 8 gauge for greater than 16 inches or one side more than 16 inches.

B. Sleeve Seals
   1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   2. 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. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
      e. Link Seal.
   3. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   4. Pressure Plates: Carbon steel. Include two for each sealing element.
   5. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element
   6. Provide fire rated seals as required. See Division 07.

2.4 **CONCRETE**

A. Switchboards and dry type transformers shall be mounted on minimum 3” high concrete pads furnished by this contractor. Size pads such that pad extends 2” beyond the perimeter of the equipment installed.

B. Poles provided for mounting exterior light fixtures shall be installed on or in concrete bases provided by the electrical contractor as detailed on drawings.

C. Concrete shall conform to Division 03 of this specification.

2.5 **UTILITY METERS**

A. Meters will be furnished by Utility Company.

B. Provide approved meter bases as required by Utility Company.

PART 3 EXECUTION

3.1 **COMMON REQUIREMENTS FOR EXAMINATION PRIOR TO ELECTRICAL INSTALLATIONS**

A. Verify conditions and constructions types prior to installation.

B. Verify that surfaces that support Product(s) are ready to receive them.

C. Examine location of equipment installation for compliance with installation tolerances and other conditions affecting performance of Work
   1. Prepare drawings showing proposed rearrangement of work to meet Project conditions, including changes to work specified in other Divisions. Obtain permission of Architect before proceeding.

D. Review all Drawings including architectural, mechanical, structural, civil, and electrical drawings for extent of Work.
   1. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.

E. Examine Architectural drawings and elevations to verify device locations and mounting heights.
   1. In finished spaces, where mounting heights are not detailed or dimensioned coordinate mounting height with Architect.
   2. Do not rough-in for any wall mounted equipment without verifying mounting height with Architect unless equipment is specifically noted on Architectural Drawings.
   3. Do not scale dimensions from Electrical Drawings and verify all mounting heights noted on Electrical Drawings.
   4. See preparation, quality assurance, and coordination requirements in section Raceways and Boxes for Electrical Systems for additional information and requirements.

F. Site Investigation
   1. Prior to beginning work, exam the work site to become familiar with existing conditions which may affect the cost of the project. This includes measurements for lengths, quantities, clearances and all other field verifiable conditions.
   2. No extra charges will be allowed because of failure of Contractor to become familiar with all existing conditions prior to beginning work.
   3. Existing equipment, systems and installations whether or not they are not detailed on the drawings must be restored to their original condition.

3.2 COMMON REQUIREMENTS FOR PREPARATION TO INSTALLATION

A. Equipment Wiring preparation
   1. Obtain and review shop drawings, product catalog data, etc. prior to roughing-in for electrical connections.
   2. Verify dimensions and final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
   3. Refer to equipment drawings and specifications in all specification Divisions for rough-in requirements.

B. Electric Utility Service Entrance preparation
   1. Make arrangements with Utility Company for installation of radio telemetry unit.
   2. Coordinate location of Utility Company's facilities to ensure proper access is available.
   3. Provide compression lugs on end of service entrance cable to be terminated at the Utility Company's transformer as required by Utility Company.
   4. Verify that field measurements are as indicated on Utility Company drawings.
   5. Pre-Installation meeting: Convene two weeks prior to commencing work of this section with Utility Company representative, General Contractor, and other trades affected by site work to coordinate final location of transformer and underground electrical Work.

C. Demolition and remodeling preparation.
   1. Notify the Owner and Architect at least five (5) days prior to commencing demolition operations
   2. Demolition Drawings are based on field observation and existing record documents. Report discrepancies to Architect before disturbing existing installation.
   3. Verify existing circuiting arrangements and control apparatus and wiring.
   4. Verify that abandoned wiring and equipment serve only abandoned facilities.
   5. Review existing equipment and materials with the Owner, schedule or indicate equipment to be salvaged for re-use and equipment to be salvaged and turned over to the Owner.
   6. Beginning of demolition means Contractor accepts existing conditions.
   7. Extension of existing circuits and or systems: Prior to connecting any new Work to existing circuits or systems Contractor shall provide field measurements and surveys required to ensure adequate capacity is available for new connections.

D. Hangers and Supports preparation
   1. Coordinate the installation of required supporting devices, inserts and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed. Strength of construction shall not be impaired.
   2. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations. Strength of construction shall not be impaired.

3. Provide plywood backboards shall be primed and painted with (2) coats of Gray enamel prior to mounting any equipment, wiring, etc

3.3 COMMON INSTALLATION REQUIRMENTS FOR ELECTRICAL WORK

A. Description Of Wiring Methods:
   1. All wiring shall be installed in accordance with applicable codes and as noted in section 26 0519, unless otherwise indicated.
   2. Multi-wire branch circuits shall not be allowed unless specifically noted. Provide separate neutral conductor for each circuit.
   3. See Section Low Voltage Electrical Power Conductors and Cables for conductor and cable requirements.
   4. See Section Raceways and Boxes for Electrical Systems for box and raceway requirements.

B. Install products in accordance with NECA 1 and manufacturer's instructions.

C. Install work in locations shown on drawings, unless prevented by Project conditions. Refer to architectural drawings for exact devices locations.

D. Conform to arrangements indicated by Contract Documents, recognizing that the Work is shown only in diagrammatic form.

E. Install systems, materials and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

F. Install materials and equipment giving right-of-way priority to systems required to be installed at a specified slope.

G. Core drilling of concrete is required, where possible, in lieu of hammer drilling. Hammer drilling is generally to be limited to small holes for anchors.

H. Install access door assembly where units are concealed behind finished surfaces. Access doors are specified in Division 08 and this section.

I. Hangers and Supports
   1. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
   2. Do not fasten supports to pipes, ducts, mechanical equipment and conduit. Do not drill or cut structural members.
   3. Fabricate supports from structural steel or formed steel members. Rigidly weld members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
   4. Install surface-mounted cabinets, disconnects, contactors, starters and panelboards with minimum of four anchors.
   5. In wet and damp locations use steel channel supports to stand cabinets, disconnects, contactors, starters and panel boards approximately one inch off wall.

J. Floor, Wall And Ceiling Penetrations
   1. Effectively seal penetrations in exterior walls, roofs, and rated interior walls in accordance with Division 07.
   2. Examine substrates, areas, and conditions, for compliance with requirements for installation tolerances and other conditions affecting installation and application of joint sealers and access door units. Do not proceed with installation until unsatisfactory conditions have been corrected.
   3. Conduits and cables passing through floors, walls, and ceilings at the following locations shall be sealed for the purpose of sound, heat, smoke and / or moisture control.
      a. Acoustically rated walls.
      b. Fire and / or smoke resistant walls and floors.
      c. All electrical rooms.
      d. All mechanical rooms.

e. All exterior walls.

f. All vertical and horizontal shafts.

g. All walls around janitor rooms, receiving rooms, and other facility maintenance and management rooms.

h. Food service areas.

4. Where conduits and raceways pass through interior walls and ceilings (not requiring water proofing) provide suitable sealing material complying with Division 07 for the wall construction; examples:
   a. Plaster for plaster walls.

   b. Joint compound for gypsum board walls.

   c. Mortar for masonry block and brick walls.

   d. Grout for concrete walls.

5. Place sealing material around each conduit and raceway for the full thickness of the wall.
6. Where conduits and raceways pass through exterior walls and ceilings below grade, provide installation to meet the details noted on the Drawings.
7. Where interior walls require waterproof conduit and raceway seals, provide silicone sealant generally installed as specified above for exterior walls.
8. Where conduits and raceways pass through exterior walls above grade, provide matching wall material inside (see examples above) and provide waterproof seal of silicone sealant or other approved sealant on outside.
9. At the nearest point of access to wires (inside conduit or raceway) passing through exterior walls and roof; provide "Ductseal" between wires and conduit or raceway as a wind barrier.
10. Where cables pass through walls, ceilings and floors, generally use same sealing method as for conduits.
11. "Ductseal" type material is generally not acceptable except as noted above.
12. Utilize fire rated cabling pathways where cabling must be routed through fire-rated floor and wall assemblies.

K. Roof Penetrations
   1. Electrical Contractor shall be responsible for providing roof seals for each raceway, mast, tower leg, guy wire, etc., which pass through roof, rest on roof or attach to roof. Avoid roof penetrations where possible. This work shall be performed by the Roofing Contractor. Electrical Contractor shall coordinate work as needed.

L. Cutting, Patching, and Finishing
   1. General: Perform cutting, patching and finishing in accordance with Division 01.
      a. Cut, remove, and legally dispose of material including but not limited to construction material, and other indicated material made obsolete by the new work.

      b. Protect the structure, furnishings, finishes, and adjacent materials and installations not indicated or scheduled to be cut or removed.

      c. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt into adjacent areas.

      d. The Contractor shall not endanger the stability of the structure by cutting, excavation or otherwise.

e. Do not cut or alter work of any other trade without trade and Architect / Engineer's consent.

2. Perform cutting, patching and finishing of walls, floors, ceilings, roofs required to:
   a. Uncover work to provide for installation of new or ill-timed work.

   b. Remove and replace defective work.

   c. Remove samples of installed work as specified for testing.

3. Upon written instructions from the Architect / Engineer, uncover and restore work to provide for Engineer's observation of concealed work.
4. Should any cutting be required for proper installation of electrical work because of failure to give the General Contractor the proper information at the time required, such cutting shall be done at the Electrical Contractors expense.

M. Equipment wiring installation
1. Provide all necessary boxes, raceways, and wiring required to make equipment and systems complete and operable.
2. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings.
3. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components.
4. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
5. Make electrical connections in accordance with equipment manufacturer's instructions.
6. Make conduit connections to equipment using flexible metal conduit. Use liquidtight flexible metal conduit with watertight connectors in damp or wet locations.
7. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
8. Provide suitable receptacle outlet to accommodate connection with attachment plug.
9. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
10. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
11. Install terminal block jumpers to complete equipment wiring requirements.
12. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

N. Elevator wiring installation
1. Provide smoke detector in each elevator lobby.
2. Provide smoke detector in each elevator equipment room.
3. Provide fixed temperature heat detector within two-feet of each sprinkler head in the elevator equipment room and in the elevator hoistway, where applicable. Temperature setting shall be below rating of sprinkler head.
4. Provide interconnection between elevator shunt trip switch with Fire Alarm and Detection System. Fire alarm system shall signal switch to operate upon alarm, and monitor voltage of shunt trip device.
5. Provide interconnection between elevator shunt trip switch and elevator controller. Signal elevator controller battery lower device when power to the switch has been lost.
6. Provide interconnection between elevator and Fire Alarm and Detection System for elevator recall to primary and secondary levels.
7. Provide keyed switch at main floor elevator lobby for manual operation of elevator hoistway smoke removal system. Provide indicator light wired to position switch of hoistway damper indicator light shall be illuminated when damper is closed.
8. Provide (1) circuit for the elevator car lighting circuit. Circuit shall originate from the Life Safety Distribution System where such system is installed within the facility. Provide lockable disconnect switch inside elevator equipment room.

9. Provide (1) circuit for elevator pit weatherproof, GFCI receptacle and elevator pit lighting. Provide lockable disconnect switch inside elevator equipment room.
10. Provide (1) circuit for light and GFCI receptacle in elevator equipment room. Provide lockable disconnect switch inside elevator equipment room.
11. Provide telephone connection to elevator cab telephone.

3.4 DEMOLITION AND REMODELING

A. General Demolition:
   1. Remove, relocate, and extend existing installations to accommodate new construction.
   2. Where indicated or required, remove existing electrical systems in walls, floors, and ceilings scheduled for removal.
   3. Where abandoned wiring serves equipment and / or facilities not indicated to be removed Contractor shall extend and / or reroute wiring to maintain service to the equipment that shall remain.
   4. Repair adjacent construction and finishes damaged during demolition and extension work.
   5. Maintain access to existing electrical installations which remain active. Modify installation or provide access door unit as appropriate.

B. Raceway and Box Demolition:
   1. Remove all abandoned conduit, unless indicated to remain for re-use or future work, including abandoned conduit exposed during demolition and located above accessible ceilings.
   2. Cut concealed abandoned conduit flush with walls and floors that are indicated to remain.
   3. Remove abandoned boxes if conduit servicing them is removed.
   4. Provide appropriate blank cover for abandoned boxes which are not removed.
   5. Disconnect and remove abandoned panelboards and distribution equipment as indicated.

C. Conductor and Cabling Demolition:
   1. Remove all abandoned conductors and cabling in their entirety.

D. Equipment Demolition:
   1. Where indicated or required, remove all luminaires, stems, brackets, hangers, supports, etc.
   2. Remove, demount, and disconnect existing electrical materials and equipment indicated to be salvaged, and deliver same to the location designated for storage. Leave in good condition and store in orderly manner.
   3. Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

E. Maintain existing systems in service until new systems are complete and ready for use.
   1. Disable existing systems only to make switchovers and connections.
   2. Notify Architect, Construction Manager, and Owner and obtain permission before partially or completely disabling systems.
   3. Minimize outage duration and coordinate time with Owner at his convenience.
   4. Make temporary connections to maintain service, feeders and branch circuits when outage time exceeds 8 hours or more.

3.5 ELECTRIC UTILITY SERVICE

A. Make arrangements with Utility Company to obtain permanent electric service to the Project.

B. Coordinate location of Utility Company's facilities to ensure proper access is available.

C. Provide compression lugs on end of service entrance cable to be terminated at the Utility Company's transformer as required by Utility Company.

D. Verify that field measurements are as indicated on Utility Company drawings.

E. Pre-Installation meeting: Convene two weeks prior to commencing work of this section with Utility Company representative, General Contractor, and other trades affected by site work to coordinate final location of transformer and underground electrical Work.

F. Underground Service Entrance

1. Install conduits on high voltage side of pad mounted utility transformer as per Utility Company or as shown on drawings.
2. Install service entrance conduits and conductors from Utility Company's pad-mounted transformer to building service entrance equipment. Unless noted otherwise, Electrical Contractor shall furnish lugs and connect service entrance conductors to pad transformers.
3. Verify size, depth and other requirements with Utility. Utility to terminate cables in CT cabinet and provide CT and metering wiring.

G. In addition to his own investigations, the Contractor is encouraged to call the following marking services prior to digging for any underground work:

1. North Dakota - 1-800-795-0555 (Location alert)

3.6 INTERRUPTIONS, ENERGIZATIONS, AND OUTAGES

A. Coordinate utility service outages and disconnections with Utility Company.

B. Provide temporary wiring, connections, and protection as required to maintain all existing systems to remain in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

C. Owner approval is required prior to electric service outages or energizations and shall be scheduled at the convenience of the Owner.

1. A written request must be submitted to the Owner / Architect / Engineer for approval a minimum of 15 days prior to outage or energization.
2. Cancellation of the planned interruption by the Owner for any reason, at any time up to 24 hours before planned interruption shall bear no additional cost to the Owner.

D. Major Feeder and Service Work Sequence: A minimum of 10 days before the requested outage, submit a schedule of proposed electric feeder and switchboard outages and energizations.

1. Include construction energizations and work performed during other than normal working hours (outside of 7:00 am to 6:00 pm Monday through Friday).
2. Include details of the work to be completed during each outage.

E. Minimize outage time and provide manpower such that work can be carried out at multiple locations if required.

F. Outages and / or energizations may require the Contractor to work at other than regular normal working hours. No extra compensation will be allowed for such times.

3.7 EQUIPMENT AND DEVICE MOUNTING HEIGHTS

A. Coordinate final mounting heights as directed under Part 3 paragraph "Preparation".

B. Interior mounting heights indicated on drawings are from finished floors (interior) or final grade (exterior). Mounting heights for items indicated on exterior walls are from the interior finished floor below.

C. Mounting heights indicated are to the top of the device plate unless noted otherwise. Mounting heights are nominal and shall be adjusted to fit block joints.

D. Typical mounting heights are detailed on the Drawings.

E. Handicapped counter and lavatory locations: meet ADA requirements for receptacle and switch locations and elevations.

F. Contractor shall verify mounting heights of all outlets to assure installation above top of radiation covers, mirrors, counters, vanity, cabinets, and any other obstruction that may alter indicated mounting heights. ADA accessible controls must be mounted at 48".

3.8 TEMPORARY FACILITIES

A. The Contractor shall provide temporary facilities according to Division 01, "TEMPORARY FACILITIES".

B. Provide temporary lighting with local switching that provides adequate illumination for construction operations as follows:

1. Incandescent light fixtures with wireguards or halogen floodlights are acceptable.
2. Provide a suitable quantity of fixtures to achieve a continuous light level of 15 footcandles for all interior access routes throughout the buildings and in stairwells. Additional temporary lighting shall be provided in mechanical rooms, electrical rooms, kitchens, and rooms over 1000 square feet. Temporary task lighting in individual rooms is the responsibility of individual contractors.
3. Provide night time flood lighting for all excavations and exterior access routes within the construction zone.
4. Relocate lighting as required to allow construction to continue.

C. Under no condition shall permanent lighting fixtures or electric heating units be used for temporary lighting or heat, unless approved in writing by Engineer.

D. Temporary lighting and power systems shall be approved by authority having jurisdiction.

3.9 OWNER INSTRUCTION AND DEMONSTRATION

A. Furnish, without additional expense to the Owner, the services of competent instructors, who will give full instructions in the care, adjustment and operation of all parts of the electrical equipment to the Owner's employees who are to have charge of the equipment. Including but not limited to the following:

1. Demonstrate the proper operation of systems per the operational and function requirements of the Contract Documents and as outlined in any sequence of operation.
2. Instruct personnel, in all phases of operation, location of components and use of all systems.
3. Review manufacturer Warranty information for all equipment included in the manual.

B. Number of hours of instruction shall be specified in other sections of this specification.

C. An operating and maintenance manual shall be made available to the Owner's operating personnel during the instruction and left with the Owner upon completion of the instruction.

D. Owner instruction / demonstration shall be provided as noted below and as noted in specification sections (see individual specification section for additional requirements):

1. Low Voltage Electrical Conductors and Cables - indicate manufacturer’s recommendations for tightening and checking bolted connections.
2. Grounding and Bonding - review building grounding and bonding systems.
3. Identification for Electrical Systems - review naming conventions, color schemes, warning labels, posted operating instructions, bolted connection labels, etc.
4. Lighting Control Devices - see specification section.
5. Electrical Distribution Equipment - provide overview of system, highlight major components and distribution equipment. Review suggested maintenance schedules.
6. Wiring Devices - review maintenance requirements (e.g. GFCI monthly test requirements).
7. Electric Space Heating Units - review control device locations, programming, and settings.
8. Surge Protective Devices - review locations, alarm indicating lights, and maintenance procedures to follow alarms are indicated.
9. Lighting Fixtures and Luminaires - review lamp changing requirements for all fixture types.

E. Documentation: Upon completion of Owner Instruction and Demonstration provide a certificate signed and dated by the attendees indicating information covered, amount of instruction / demonstration time provided, and applicable specification sections. Provide certificate for all Owner Instruction and Demonstration sessions. Include copy with O & M Manual. A sample certificate is attached for reference.

3.10 FIELD QUALITY CONTROL

A. So far as possible contractor shall keep same foreman and workmen throughout project duration. Keep enough workmen on job to insure keeping up with or ahead of other trades so that no delays occur.

B. Delivery, Storage, and Handling

1. Deliver, store, protect and handle products on site under provisions of Division 01 according to manufacturer’s recommendations and as specified herein.
2. This Contractor shall make provisions for delivery and safe storage of materials.
3. Accept Products on site. Inspect for damage

4. Protect Products from corrosion and entrance of debris. Provide appropriate covering. During construction, it shall be the responsibility of this Contractor to protect the surface of equipment and material furnished.
5. See individual specifications sections for specific delivery, storage, handling and protection requirements.

3.11 CLEAN-UP, KEY CONTROL, AND PAINTING

A. Remove all packing materials, rubbish, debris, etc. from the site each day.

B. String all furnished keys on split metal key ring and turn same over to Owner at project completion.

END OF SECTION

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SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Single conductor building wire.
B. Service entrance cable.
C. Metal-clad cable.
D. Variable-frequency drive cable.
E. Wiring connectors.

1.2 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2018).
B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011 (Reapproved 2017).
C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).
D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2020).
E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
F. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); 2012.
G. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2009.
H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. NFPA 79 - Electrical Standard for Industrial Machinery; 2018.
J. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.
K. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
L. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
M. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
N. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
O. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
P. UL 1479 - Standard for Fire Tests of Through-Penetration Firestops
Q. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.
R. UL 2277 - Outline of Investigation for Flexible Motor Supply Cable and Wind Turbine Tray Cable; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate the installation of direct burial cable with other trades to avoid conflicts with piping or other potential conflicts.
   3. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
   4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.5 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Engineer and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.1 Description of System

A. Conductor and conduit sizes noted are based on type THHN copper unless noted otherwise.

B. Conductor material applications:

1. Feeders for panelboards, switchboards, and other distribution equipment: Copper. Aluminum Conductors are not acceptable.
2. Motor Feeders: Copper. Aluminum Conductors are not acceptable.
3. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
   a. Use stranded conductors for control circuits.
   b. Use conductor not smaller than 12 AWG for power and lighting circuits.
   c. Use conductor not smaller than 16 AWG for control circuits.

C. Wiring Methods

1. See Section 26 0533 for raceway system requirements.
2. Service Entrance: Type THHN-THWN single conductors in raceway or Type XHHW-2, single conductors in raceway.
3. Feeders for panelboards, switchboards, and other distribution equipment: Type THHN-THWN or XHHW-2 single conductors in raceway.
4. Motor Feeders: Type THHN-THWN or XHHW-2 single conductors in raceway.
5. Branch Circuits:
   a. Multi-wire branch circuits shall not be acceptable. Provide dedicated neutral conductor for each circuit.
   b. Home Runs (from circuit breaker to junction box at accessible location adjacent to first wiring device): Type THHN-THWN single conductors in raceway.
   c. Exposed (including in crawl spaces, electrical rooms, mechanical rooms, and above accessible ceilings): Type THHN-THWN single conductors in raceway.
   d. Concealed (e.g. in ceilings, walls, partitions): Type THHN-THWN single conductors in raceway.
6. Wiring for Variable Frequency Drives:
   a. Input to the VFD: Copper, 600V, 90 degree C, THHN, THWN-2, XHHW2, RHH, or RHW-2. Single conductors in conduit.
   b. Output from VFD to equipment: variable-frequency drive cable.
7. Class 1 Control Circuits: Type THHN-THWN single conductors in raceway.
8. Class 2 Control Circuits:

a. For lighting control devices (occupancy sensors, low-voltage switches, etc.), exposed multi-conductor cable, plenum rated shall be acceptable in concealed locations. Install cabling in accordance with Section 27 0528.

b. Unless otherwise noted all other locations use type THHN-THWN single conductors in raceway.

2.2 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

1. Exceptions:
   a. Use variable-frequency drive cable for connection between variable-frequency motor controllers and associated motors.

C. Metal-clad cable is permitted only as follows:

1. Where not otherwise restricted, may be used:
   a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.

      1) Maximum Length: 6 feet.

2. In addition to other applicable restrictions, may not be used:
   a. Where not approved for use by the authority having jurisdiction.

   b. Where exposed to view.

   c. Where exposed to damage.

   d. For damp, wet, or corrosive locations.

   e. For isolated ground circuits.

3. Metal-clad Luminary Cable is permitted only as follows:
   a. Where not otherwise restricted, may be used:

      1) Where concealed above accessible ceilings for final connections from junction boxes to luminaires.

      2) Where concealed in hollow stud walls, above accessible ceilings, and under raised floors for branch circuits up to 20 A.

D. CONDUCTOR AND CABLE GENERAL REQUIREMENTS

1. Provide products that comply with requirements of NFPA 70.
2. Provide products listed, classified, and labeled as suitable for the purpose intended.
3. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
4. Comply with NEMA WC 70.
5. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
6. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
7. Conductor Material:

a. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.

b. Tinned Copper Conductors: Comply with ASTM B33.

8. Minimum Conductor Size:
   a. Branch Circuits: 12 AWG.
      1) Upsizing for voltage drop: voltage drop is not to exceed 5% total drop as measured at the furthest device on a circuit. The values indicated below are based on installed circuit lengths; contractors must account for circuit routing used in the field:
         a) For 20A, 120V branch circuits serving only convenience receptacles:
            1 Use 10 AWG conductors for circuits longer than 100ft.
            2 Use 8 AWG conductors for circuits longer than 175ft.
         b) For 20A, 120V branch circuits serving anything other than convenience receptacles:
            1 Use 10 AWG conductors for circuits longer than 60ft.
            2 Use 8 AWG conductors for circuits longer than 115ft.
         c) For 20A, 277V branch circuits:
            1 Use 10 AWG conductors for circuits longer than 150ft.
            2 Use 8 AWG conductors for circuits longer than 245ft.

9. Conductor Color Coding:
   a. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
   b. Color Coding Method: Integrally colored insulation.
   c. Color Code:
      1) 480Y/277 V, 3 Phase, 4 Wire System:
         a) Phase A: Brown.
         b) Phase B: Orange.
         c) Phase C: Yellow.
         d) Neutral/Grounded: Gray.
      2) 208Y/120 V, 3 Phase, 4 Wire System:
         a) Phase A: Black.

b) Phase B: Red.

c) Phase C: Blue.

d) Neutral/Grounded: White.

3) Equipment Ground, All Systems: Green.

E. SINGLE CONDUCTOR BUILDING WIRE

1. Description: Single conductor insulated wire.
2. Conductor Stranding:
   a. Feeders and Branch Circuits:

      1) Size 10 AWG and Smaller: Solid.

      2) Size 8 AWG and Larger: Stranded.

3. Insulation Voltage Rating: 600 V.
4. Insulation:
   a. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.

F. METAL-CLAD CABLE

1. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
2. Conductor Stranding:
   a. Size 10 AWG and Smaller: Solid.

   b. Size 8 AWG and Larger: Stranded.

3. Insulation Voltage Rating: 600 V.
4. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
5. Grounding: Full-size integral equipment grounding conductor.
6. Armor: Steel, interlocked tape.

G. VARIABLE-FREQUENCY DRIVE CABLE

1. Description: Flexible motor supply cable listed and labeled as complying with UL 2277 in accordance with NFPA 79; specifically designed for use with variable frequency drives and associated nonlinear power distortions.
2. Conductor Stranding: Stranded.
3. Insulation Voltage Rating: 1000 V.
4. Insulation: Use only thermoset insulation types; thermoplastic insulation types are not permitted.
5. Grounding: Full-size integral equipment grounding conductor or symmetrical arrangement of multiple conductors of equivalent size.
6. Provide metallic shielding.
7. Jacket: PVC or Chlorinated Polyethylene (CPE).

H. WIRING CONNECTORS

1. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
2. Wiring Connectors for Splices and Taps:
   a. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.

   b. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.

3. Wiring Connectors for Terminations:
   a. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.

   b. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.

   c. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.

   d. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.

4. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
5. Mechanical Connectors: Provide bolted type or set-screw type.
6. Compression Connectors: Provide circumferential type or hex type crimp configuration.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that interior of building has been protected from weather.
B. Verify that work likely to damage wire and cable has been completed.
C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
D. Verify that field measurements are as indicated.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

A. Circuiting Requirements:
   1. Unless dimensioned, circuit routing indicated is diagrammatic.
   2. When circuit destination is indicated without specific routing, determine exact routing required.
   3. Arrange circuiting to minimize splices.
   4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
   5. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is not permitted.
   6. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
B. Install products in accordance with manufacturer's instructions.
C. Perform work in accordance with NECA 1 (general workmanship).
D. Install metal-clad cable (Type MC) in accordance with NECA 120.
E. Installation in Raceway:
   1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
   2. Pull all conductors and cables together into raceway at same time.
   3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.

4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

F. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

G. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.

1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.

H. Terminate cables using suitable fittings.

1. Metal-Clad Cable (Type MC):
   a. Use listed fittings.

   b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

I. Variable-Frequency Drive Cable: Terminate shielding at both variable-frequency motor controller and associated motor using glands or termination kits recommended by manufacturer.

J. Install conductors with a minimum of 12 inches of slack at each outlet.

K. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.

L. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

M. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

N. Make wiring connections using specified wiring connectors.

1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
3. Do not remove conductor strands to facilitate insertion into connector.
4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

O. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.

P. Insulate ends of spare conductors using vinyl insulating electrical tape.

Q. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

R. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

S. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

T. Connection of 0-10V fixtures: 0-10V dimming circuit shall not be run in same conduit as 120/277V connection for fixture.

END OF SECTION

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SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Grounding and bonding requirements.
B. Conductors for grounding and bonding.
C. Connectors for grounding and bonding.
D. Ground bars.
E. Ground rod electrodes.

1.2 REFERENCE STANDARDS

A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2007.
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
E. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify exact locations of underground metal water service pipe entrances to building.
   2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
   3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
B. Sequencing:
   1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.4 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
D. Grounding System Resistance:
   1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Engineer. Precipitation within the previous 48 hours does not constitute normally dry conditions.
   2. Grounding Electrode System: Not greater than 25 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
E. Grounding Electrode System:

1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
   a. Provide continuous grounding electrode conductors without splice or joint.

   b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.

2. Metal Underground Water Pipe(s):
   a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.

   b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.

   c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.

3. Metal In-Ground Support Structure:
   a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.

4. Concrete-Encased Electrode:
   a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.

5. Ground Rod Electrode(s):
   a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.

   b. Space electrodes not less than 10 feet from each other and any other ground electrode.

   c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.

6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.

F. Bonding and Equipment Grounding:
   1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
   2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
   3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
   4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
   a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
   1. Provide products listed, classified, and labeled as suitable for the purpose intended.
   2. Provide products listed and labeled as complying with UL 467 where applicable.
B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
   1. Use insulated copper conductors unless otherwise indicated.
      a. Exceptions:
         1) Use bare copper conductors where installed underground in direct contact with earth.
         2) Use bare copper conductors where directly encased in concrete (not in raceway).
C. Connectors for Grounding and Bonding:
   1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
   2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
      a. Exceptions:
         1) Use mechanical connectors for connections to electrodes at ground access wells.
   3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
      a. Exceptions:
         1) Use exothermic welded connections for connections to metal building frame.
D. Ground Rod Electrodes:
   1. Comply with NEMA GR 1.
   2. Material: Copper-bonded (copper-clad) steel.
   3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that work likely to damage grounding and bonding system components has been completed.
B. Verify that field measurements are as indicated.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Perform work in accordance with NECA 1 (general workmanship).

C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.

D. Make grounding and bonding connections using specified connectors.

1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

E. Identify grounding and bonding system components in accordance with Section 26 05 53.

END OF SECTION

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.2 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2019.

D. MFMA-4 - Metal Framing Standards Publication; 2004.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.3 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 Engineer 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 in accordance with Section 03 30 00.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with applicable building code.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
3. 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 with a minimum safety factor of 2. Include consideration for vibration, equipment operation, and shock loads where applicable.

4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
   a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
   b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
   c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
   d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
   1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
   2. Conduit Clamps: Bolted type unless otherwise indicated.
C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
   1. Comply with MFMA-4.
E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
F. Anchors and Fasteners:
   1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

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

A. Install products in accordance with manufacturer's instructions.
B. Perform work in accordance with NECA 1 (general workmanship).
C. Do not install hangers or supports to the bottom chord of joists.
D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
E. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.
F. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.
G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
H. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

I. Secure fasteners according to manufacturer's recommended torque settings.

J. Remove temporary supports.

K. Identify independent electrical component support wires above accessible ceilings (only where specifically indicated or permitted) with color distinguishable from ceiling support wires in accordance with NFPA 70.

END OF SECTION

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SECTION 26 05 33.13 - CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).
B. Intermediate metal conduit (IMC).
C. PVC-coated galvanized steel rigid metal conduit (RMC).
D. Flexible metal conduit (FMC).
E. Liquidtight flexible metal conduit (LFMC).
F. Electrical metallic tubing (EMT).
G. Reinforced thermosetting resin conduit (RTRC).
H. Conduit fittings.

1.2 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2015.
B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2015.
C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2018.
D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.
F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
G. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2018.
H. NEMA TC 14 (SERIES) - Reinforced Thermosetting Resin Conduit and Fittings Series; 2015.
I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
J. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
K. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
L. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
M. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
N. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
O. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
    1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
    2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
    3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
    4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
    5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
B. Sequencing:

1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.4 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:

1. Under Slab on Grade: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
3. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
4. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.
5. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection or use PVC-coated galvanized steel rigid metal conduit.

D. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

E. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

F. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

G. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.

H. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

I. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).

1. Locations subject to physical damage include, but are not limited to:
   a. Where exposed below 8 feet, except within electrical and communication rooms or closets.

J. Exposed, Exterior: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or PVC-coated galvanized steel rigid metal conduit.

K. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.

1. Maximum Length: 6 feet.

L. Connections to Vibrating Equipment:

1. Dry Locations: Use flexible metal conduit.
2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
3. Maximum Length: 6 feet unless otherwise indicated.
4. Vibrating equipment includes, but is not limited to:

a. Transformers.

b. Motors.

2.2 CONDUIT REQUIREMENTS

A. Electrical Service Conduits: Also comply with Section 26 21 00.

B. Communications Systems Conduits: Also comply with Section 27 10 00.

C. Fittings for Grounding and Bonding: Also comply with Section 26 05 26.

D. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

E. Provide products listed, classified, and labeled as suitable for the purpose intended.

F. Minimum Conduit Size, Unless Otherwise Indicated:

1. Branch Circuits: 1/2 inch (16 mm) trade size.
2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
3. Flexible Connections to Luminaires: 3/8 inch (12 mm) trade size.
4. Underground, Exterior: 1 inch (27 mm) trade size.

G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:

1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.4 INTERMEDIATE METAL CONDUIT (IMC)

A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings:

1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.5 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.

B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.

C. PVC-Coated Fittings:

1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.

D. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

2.6 FLEXIBLE METAL CONDUIT (FMC)

A. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.

2.7 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.

2.8 ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel or malleable iron.
3. Connectors and Couplings: Use compression (gland) or set-screw type.
   a. Do not use indenter type connectors and couplings.

2.9 REINFORCED THERMOSETTING RESIN CONDUIT (RTRC)

A. Description: NFPA 70, Type RTRC reinforced thermosetting resin conduit complying with NEMA TC 14 (SERIES).

B. Supports: Per manufacturer's recommendations.

C. Fittings: Same type and manufacturer as conduit to be connected.

1. Cement-Tight Joints: Use bonded coupling or bell and spigot.
2. Cement- and Water-Tight Joints: Use adhesive and manufacturer's standard gaskets.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive conduits.

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

3.2 INSTALLATION

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

B. Perform work in accordance with NECA 1 (general workmanship).

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install intermediate metal conduit (IMC) in accordance with NECA 101.

E. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.

F. A cable, raceway or box, installed in exposed or concealed locations under roof decking, shall be installed more that 1.5 inches from the lowest point of the roof decking to the top of the cable, raceway or box.

G. Conduit Routing:

1. Unless dimensioned, conduit routing indicated is diagrammatic.
2. When conduit destination is indicated without specific routing, determine exact routing required.
3. Conceal all conduits unless specifically indicated to be exposed.
4. Conduits in the following areas may be exposed, unless otherwise indicated:
   a. Electrical rooms.
   b. Mechanical equipment rooms.
   c. Within joists in areas with no ceiling.
5. Unless otherwise approved, do not route conduits exposed:
   a. Across floors.
   b. Across roofs.
   c. Across top of parapet walls.
   d. Across building exterior surfaces.
6. Conduits installed underground or embedded in concrete may be routed in the shortest possible manner unless otherwise indicated. Route all other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
7. Arrange conduit to maintain adequate headroom, clearances, and access.
8. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
9. Arrange conduit to provide no more than 150 feet between pull points.
10. Route conduits above water and drain piping where possible.
11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
   a. Heaters.
   b. Hot water piping.
   c. Flues.
14. Group parallel conduits in the same area together on a common rack.

H. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
   a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.

5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
7. Use of wire for support of conduits is not permitted.

I. Connections and Terminations:

1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

J. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

K. Underground Installation:

1. Provide trenching and backfilling in accordance with Section 31 23 16 and Section 31 23 23.

L. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:

1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where calculated in accordance with NFPA 70 for reinforced thermosetting resin conduit (RTRC) conduit installed above ground to compensate for thermal expansion and contraction.
3. Where conduits are subject to earth movement by settlement or frost.
4. Any runs over 200 feet.

M. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:

1. Where conduits pass from outdoors into conditioned interior spaces.
2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

N. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

O. Provide grounding and bonding in accordance with Section 26 05 26.

3.3 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

END OF SECTION

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SECTION 26 05 33.16 - BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
C. Floor boxes.
D. Poke thru box assemblies.

1.2 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013 (Reaffirmed 2020).
E. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
I. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
J. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
   4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
   5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
   6. Coordinate the work with other trades to preserve insulation integrity.
   7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
   8. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for floor boxes.

1.5 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 BOXES

A. General Requirements:
   1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
   2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
   3. Provide products listed, classified, and labeled as suitable for the purpose intended.
   4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
   5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
   1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
   2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
   3. Use suitable concrete type boxes where flush-mounted in concrete.
   4. Use suitable masonry type boxes where flush-mounted in masonry walls.
   5. Use raised covers suitable for the type of wall construction and device configuration where required.
   6. Use shallow boxes where required by the type of wall construction.
   7. Do not use "through-wall" boxes designed for access from both sides of wall.
   8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
   9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
   10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
   11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
   12. Wall Plates: Comply with Section 26 27 26.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
   1. Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
   2. NEMA EN 10250 Environment Type, Unless Otherwise Indicated:
   3. Junction and Pull Boxes Larger Than 100 cubic inches:
      a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

D. Floor Boxes:
   1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 27 26; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
   2. Use cast iron floor boxes within slab on grade.
   3. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
   4. Manufacturer: Same as manufacturer of floor box service fittings.

E. Poke Thru Floor Boxes
   1. Poke Through System
      a. Manufacturers:
         1) Wiremold

2) Steel City

3) Hubbell

4) Substitutions under provisions of Division 01 and Section - Electrical General Requirements.

b. Description: Assembly comprising service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination.

c. Fire Rating: 3 hours.

d. Service Fitting:

1) Type: Flush Furniture feed Pedestal.

2) Housing: Satin aluminum.

e. Device Plate: Finish to be selected by the Architect from standard colors.

f. Power: two duplex receptacles.

g. Communications: six modular jack.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that mounting surfaces are ready to receive boxes.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
D. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
E. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
F. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
G. Box Locations:
1. Locate boxes to be accessible. Provide access panels in accordance with Section 08 31 00 as required where approved by the Architect.
2. Unless dimensioned, box locations indicated are approximate.
3. Locate boxes as required for devices installed under other sections or by others.
a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 27 26.

b. Communications Systems Outlets: Comply with Section 27 10 00.

4. Locate boxes so that wall plates do not span different building finishes.

5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
6. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
7. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.

H. Box Supports:
1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.

I. Install boxes plumb and level.

J. Flush-Mounted Boxes:
1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

K. Install boxes as required to preserve insulation integrity.

L. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.

M. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

O. Close unused box openings.

P. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

Q. Provide grounding and bonding in accordance with Section 26 05 26.

3.3 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.4 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical identification requirements.
B. Identification nameplates and labels.
C. Underground warning tape.
D. Warning signs and labels.

1.2 REFERENCE STANDARDS

A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.
B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
D. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
B. Sequencing:
   1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
   2. Do not install identification products until final surface finishes and painting are complete.

1.4 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

A. Identification for Equipment:
   1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
      a. Switchboards:
         1) Identify ampere rating.
         2) Identify voltage and phase.
         3) Identify power source and circuit number. Include location when not within sight of equipment.
         4) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
      b. Panelboards:
         1) Identify ampere rating.

2) Identify voltage and phase.

3) Identify power source and circuit number. Include location when not within sight of equipment.

4) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.

5) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.

c. Transformers:

1) Identify kVA rating.

2) Identify voltage and phase for primary and secondary.

3) Identify power source and circuit number. Include location when not within sight of equipment.

4) Identify load(s) served. Include location when not within sight of equipment.

d. Enclosed switches, circuit breakers, and motor controllers:

1) Identify voltage and phase.

2) Identify power source and circuit number. Include location when not within sight of equipment.

3) Identify load(s) served. Include location when not within sight of equipment.

2. Service Equipment:
   a. Use identification nameplate to identify each service disconnecting means.

3. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
4. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations indicated.
   a. Service equipment.

5. Arc Flash Hazard Warning Labels: Comply with Section 26 05 73.

B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.

C. Identification for Devices:
1. Identification for Communications Devices: Comply with Section 27 10 00.
2. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.
3. Use identification label to identify fire alarm system devices.
4. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.

5. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:
   1. Materials:
      a. Indoor Clean, Dry Locations: Use plastic nameplates.
      b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
   2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
   3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
   4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
   5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:
   1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
   2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

C. Format for Equipment Identification:
   1. Minimum Size: 1 inch by 2.5 inches.
   2. Legend:
      a. Equipment designation or other approved description.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height:
      a. Equipment Designation: 1/2 inch.
   5. Color:
      a. Normal Power System: White text on black background.

D. Format for Receptacle Identification:
   1. Minimum Size: 3/8 inch by 1.5 inches.
   2. Legend: Power source and circuit number or other designation indicated.
   3. Text: All capitalized unless otherwise indicated.
   4. Minimum Text Height: 3/16 inch.
   5. Color: Black text on clear background.

2.3 UNDERGROUND WARNING TAPE

A. Materials: Use non-detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

B. Non-detectable Type Tape: 6 inches wide, with minimum thickness of 4 mil.

C. Legend: Type of service, continuously repeated over full length of tape.

D. Color:

2.4 Identify conduit and boxes as follows:

A. Accessible Raceways 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A: Identify with orange snap-around label or stenciled legend adjacent to each junction box, pull box, and electrical

enclosure. Indicate type of system and circuits located within (i.e. Normal or Emergency, 208/120 volt or 480/277 volt, panel ID and circuit number).

B. Use the following color code for conduit and junction box covers:
   1. Fire Alarm - Red.
   2. Voice and Data - Blue
   3. Access Control - Orange.

C.

2.5 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:
   1. Materials:
      a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.

      b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.

   2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
   3. Minimum Size: 7 by 10 inches unless otherwise indicated.

C. Warning Labels:
   1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
   2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
   3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.1 INSTALLATION

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

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   1. Surface-Mounted Equipment: Enclosure front.
   2. Flush-Mounted Equipment: Inside of equipment door.
   3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   4. Elevated Equipment: Legible from the floor or working platform.
   5. Branch Devices: Adjacent to device.
   6. Interior Components: Legible from the point of access.
   7. Conductors and Cables: Legible from the point of access.
   8. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.

E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.

G. Secure rigid signs using stainless steel screws.

H. Mark all handwritten text, where permitted, to be neat and legible.

3.2 Operator Instructions

A. Instructions shall be mounted in protective enclosure adjacent to the electrical service room (power distribution equipment, and fire alarm system) or the communications equipment room.

B. Posted instructions / documentation shall be prepared for the following systems with the information noted:

C. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

D. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

END OF SECTION

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SECTION 26 05 73 - POWER SYSTEM STUDIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Short-circuit study.
B. Protective device coordination study.
C. Arc flash and shock risk assessment.
   1. Includes arc flash hazard warning labels.
D. Criteria for the selection and adjustment of equipment and associated protective devices not specified in this section, as determined by studies to be performed.

1.2 REFERENCE STANDARDS

A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.
B. IEEE 141 - IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants; 1993 (Reaff 1999).
C. IEEE 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems; 2001, with Errata, 2003.
D. IEEE 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis; 1997.
E. IEEE 551 - IEEE Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems; 2006.
F. IEEE 1584 - IEEE Guide for Performing Arc Flash Hazard Calculations; 2002, including 1584a (2004) and 1584b (2011) amendments.
G. NEMA MG 00001 - Motors and Generators; 2024.
H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.
I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
J. NFPA 70E - Standard for Electrical Safety in the Workplace; 2015.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work to provide equipment and associated protective devices complying with criteria for selection and adjustment, as determined by studies to be performed.
   2. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
B. Sequencing:
   1. Submit study reports prior to or concurrent with product submittals.
   2. Do not order equipment until matching study reports and product submittals have both been evaluated by Engineer.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Study reports, stamped or sealed and signed by study preparer.

1.5 POWER SYSTEM STUDIES

A. Scope of Studies:
   1. Except where study descriptions below indicate exclusions, analyze system at each bus from primary protective devices of utility source down to each piece of equipment involved, including parts of system affecting calculations being performed (e.g. fault current contribution from motors).

2. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.

B. General Study Requirements:
   1. Comply with NFPA 70.
   2. Perform studies utilizing computer software complying with specified requirements; manual calculations are not permitted.

C. Data Collection:
   1. Compile information on project-specific characteristics of actual installed equipment, protective devices, feeders, etc. as necessary to develop single-line diagram of electrical distribution system and associated input data for use in system modeling.
      a. Utility Source Data: Include primary voltage, maximum and minimum three-phase and line-to-ground fault currents, impedance, X/R ratio, and primary protective device information.
         1) Obtain up-to-date information from Utility Company.
         2) Utility Company: As indicated on drawings.
      b. Generators: Include manufacturer/model, kW and voltage ratings, and impedance.
      c. Motors: Include manufacturer/model, type (e.g. induction, synchronous), horsepower rating, voltage rating, full load amps, and locked rotor current or NEMA MG 00001 code letter designation.
      d. Transformers: Include primary and secondary voltage ratings, kVA rating, winding configuration, percent impedance, and X/R ratio.
      e. Protective Devices:
         1) Circuit Breakers: Include manufacturer/model, type (e.g. thermal magnetic, electronic trip), frame size, trip rating, voltage rating, interrupting rating, available field-adjustable trip response settings, and features (e.g. zone selective interlocking).
         2) Fuses: Include manufacturer/model, type/class (e.g. Class J), size/rating, and speed (e.g. time delay, fast acting).
      f. Protective Relays: Include manufacturer/model, type, settings, current/potential transformer ratio, and associated protective device.
      g. Conductors: Include feeder size, material (e.g. copper, aluminum), insulation type, voltage rating, number per phase, raceway type, and actual length.

D. Short-Circuit Study:
   1. Comply with IEEE 551 and applicable portions of IEEE 141, IEEE 242, and IEEE 399.
   2. For purposes of determining equipment short circuit current ratings, consider conditions that may result in maximum available fault current, including but not limited to:
      a. Maximum utility fault currents.
      b. Maximum motor contribution.
      c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

3. For each bus location, calculate the maximum available three-phase bolted symmetrical and asymmetrical fault currents. For grounded systems, also calculate the maximum available line-to-ground bolted fault currents.

E. Protective Device Coordination Study:
1. Comply with applicable portions of IEEE 242 and IEEE 399.
2. Analyze alternate scenarios considering known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

F. Arc Flash and Shock Risk Assessment:
1. Comply with NFPA 70E.
2. Perform incident energy and arc flash boundary calculations in accordance with IEEE 1584 (as referenced in NFPA 70E Annex D), where applicable.
3. Analyze alternate scenarios considering conditions that may result in maximum incident energy, including but not limited to:
   a. Maximum and minimum utility fault currents.
   b. Maximum and minimum motor contribution.
   c. Known operating modes (e.g. utility as source, generator as source, utility/generator in parallel, bus tie breaker open/close positions).

G. Study Reports:
1. General Requirements:
   a. Identify date of study and study preparer.
   b. Identify study methodology and software product(s) used.
   c. Identify scope of studies, assumptions made, implications of possible alternate scenarios, and any exclusions from studies.
   d. Identify base used for per unit values.
   e. Include single-line diagram and associated input data used for studies; identify buses on single-line diagram as referenced in reports, and indicate bus voltage.
   f. Include conclusions and recommendations.
2. Short-Circuit Study:
   a. For each scenario, identify at each bus location:
      1) Calculated maximum available symmetrical and asymmetrical fault currents (both three-phase and line-to-ground where applicable).
      2) Fault point X/R ratio.
      3) Associated equipment short circuit current ratings.
   b. Identify locations where the available fault current exceeds the equipment short circuit current rating, along with recommendations.
3. Protective Device Coordination Study:
   a. For each scenario, include time-current coordination curves plotted on log-log scale graphs.
   b. For each graph include (where applicable):

1) Partial single-line diagram identifying the portion of the system illustrated.

2) Protective Devices: Time-current curves with applicable tolerance bands for each protective device in series back to the source, plotted up to the maximum available fault current at the associated bus.

3) Conductors: Damage curves.

4) Transformers: Inrush points and damage curves.

5) Generators: Full load current, overload curves, decrement curves, and short circuit withstand points.

6) Motors: Full load current, starting curves, and damage curves.

7) Capacitors: Full load current and damage curves.

c. For each protective device, identify fixed and adjustable characteristics with available ranges and recommended settings.

1) Circuit Breakers: Include long time pickup and delay, short time pickup and delay, and instantaneous pickup.

2) Include ground fault pickup and delay.

3) Include fuse ratings.

4) Protective Relays: Include current/potential transformer ratios, tap, time dial, and instantaneous pickup.

d. Identify cases where either full selective coordination or adequate protection is not achieved, along with recommendations.

4. Arc Flash and Shock Risk Assessment:

a. For the worst case for each scenario, identify at each bus location:

1) Calculated incident energy and associated working distance.

2) Calculated arc flash boundary.

3) Bolted fault current.

4) Arcing fault current.

5) Clearing time.

6) Arc gap distance.

b. For purposes of producing arc flash hazard warning labels, summarize the maximum incident energy and associated data reflecting the worst case condition of all scenarios at each bus location.

1.6 QUALITY ASSURANCE

A. Study Preparer Qualifications: Professional electrical engineer licensed in the State in which the Project is located and with minimum five years experience in the preparation of studies of similar type and complexity using specified computer software.

B. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.

PART 2 PRODUCTS

2.1 ARC FLASH HAZARD WARNING LABELS

A. Provide warning labels complying with ANSI Z535.4 to identify arc flash hazards for each work location analyzed by the arc flash and shock risk assessment.

1. Materials: Comply with Section 26 05 53.
2. Legend: Provide custom legend in accordance with NFPA 70E based on equipment-specific data as determined by arc flash and shock risk assessment.
   a. Include the following information:

      1) Arc flash boundary.

      2) Available incident energy and corresponding working distance.

      3) Nominal system voltage.

      4) Limited approach boundary.

      5) Restricted approach boundary.

      6) Equipment identification.

      7) Date calculations were performed.

PART 3 EXECUTION

3.1 INSTALLATION

3.2 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Adjust equipment and protective devices for compliance with studies and recommended settings.

D. Notify Engineer of any conflicts with or deviations from studies. Obtain direction before proceeding.

3.3 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

END OF SECTION

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SECTION 26 08 13 - TESTING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section includes general requirements that pertain to all Performance Verification Testing and Acceptance Testing requirements listed in Division 26 specifications.

B. See Part 3 paragraph titled “Field Quality Control” of individual specification sections of Division 26 for test methods, procedures, test values, etc. specific to the materials and labor specified in that section.

C. This section includes required tests applicable to Division 26 work in general.

1.2 RELATED DOCUMENTS

A. Drawings, addenda and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification Sections, apply to this and all other sections of Division 26.

B. Division 26 Specification Sections:

1. 26 0100 Electrical Systems Close Out Documentation
2. 26 0519 Low Voltage Electrical Power Conductors and Cables
3. 26 0526 Grounding and Bonding for Electrical Systems
4. 26 0920 Lighting Control Devices and Systems
5. 26 2000 Low Voltage Electrical Distribution Equipment
6. 26 2726 Wiring Devices
7. 26 4300 Surge Protective Devices
8. 26 5100 Lighting Fixtures and Luminaires

1.3 DEFINITIONS

A. See Section 26 0000 for definition of performance verification testing and acceptance testing.

1.4 REFERENCES

A. NFPA 70 - National Electrical Code.

B. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).

C. Occupational Safety and Health Act (OSHA).

D. ANSI/NFPA 70E, Standard for Electrical Safety in the Workplace.

E. Owner’s Safety Practices.

1.5 SCOPE OF WORK

A. Electrical Contractor shall demonstrate proper operation of all equipment installed under these specifications to the Architect / Engineer and Owner’s representative.

1. Architect and Engineer and Owner shall be allowed to observe field acceptance testing and / or performance verification testing.
2. Work involved with testing shall be coordinated with the Architect and Engineer and Owner and other Subcontractors.

B. At the time of final observation, be prepared to test and operate any system as required by Architect, Engineer, or Owner’s representative.

C. Perform specified Acceptance Testing after installation and wiring of equipment is complete and after performance verification testing is complete.

D. Electrical Systems to be Tested include the following:

1. Secondary Service Electrical System.
2. Grounding and Bonding Systems.
3. Elevator Systems.

4. Distribution and Branch Circuit Panelboards.
5. Distribution Switchboards.
6. Lighting Fixtures, Control Devices, and Control Systems.

E. Division of Responsibility for Performance Verification Testing:

1. The Electrical Contractor shall provide performance verification testing.
2. All required documentation shall be provided by the Electrical Contractor including contract documents, specifications, equipment submittal data (e.g. shop drawings).
3. Electrical Contractor shall provide a short-circuit analysis, a coordination study, and a protective device setting sheet.
4. All required documentation.
5. Notification to the Architect of test dates and times.

F. Division of Responsibility for Acceptance Testing:

1. As noted in NETA Acceptance Testing Specifications section 4 with modifications noted below.
2. The Engineer shall provide the testing organization with the following:
   a. An itemized description of equipment to be inspected and tested.
3. Third Party Testing Agency shall provide the following:
   a. All field technical services, tooling, equipment, instrumentation, and technical supervision to perform specified tests and inspections.
   b. Specific power requirements for test equipment.
   c. Notification to the owner's representative prior to commencement of any testing.
   d. A timely notification of any system, material, or workmanship that is found deficient based on the results of the acceptance tests.
   e. A written record of all tests and a final report.
4. The Electrical Contractor shall provide the following:
   a. A short-circuit analysis and arc flash study.
   b. A complete set of electrical plans and specifications, including all change orders.
   c. Drawings and instruction manuals applicable to the scope of work.
   d. Site-specific hazard notification and safety training.
   e. A suitable and stable source of electrical power to test site.
   f. Preliminary low-voltage insulation-resistance, continuity, and low-voltage motor rotation tests prior to testing by independent third party testing agency.
   g. Notification to the Owner and Third Party Testing Agency of when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.
   h. Electrical Contractor shall modify installations to improve test results.

1.6 QUALITY ASSURANCE

A. Provide testing in accordance with NETA Acceptance Testing Specifications section 3 with modifications.

B. Acceptance Testing Organization

1. The testing organization shall be an independent, third party entity which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems being evaluated.
2. The testing organization shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. Testing Personnel: Technicians performing these electrical tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated. These individuals shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. They must evaluate the test data and make a judgment on the serviceability of the specific equipment.

1.7 SAFETY AND PRECAUTIONS

A. As noted in specification section - Basic Electrical Materials and Methods and utilize Safety and Precaution procedure identified in NETA Acceptance Testing Specifications Section 5.1.

1.8 SUBMITTALS FOR CLOSEOUT

A. Submit according to the requirements of Division 01 and Section 26 0100.

B. Operation and Maintenance Manuals: All test reports and / or certificates shall be included with the O & M Manuals.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

A. Utilize suitable test equipment as identified in NETA Acceptance Testing Specifications section 5.2 and as noted herein.

B. Provide all specialized tools, test equipment and instruments required to execute Start-up, checkout, and testing of equipment.

C. All specialized tools, test equipment and instruments shall be of sufficient quality and accuracy to test and/or measure system performance within specified tolerances.

D. Calibration:

1. Test instruments shall be calibrated in accordance with NETA Acceptance Testing Specifications section 5.3.
2. A testing laboratory must have calibrated test equipment within the previous twelve (12) months.
3. Contractor must calibrate test equipment and instruments according to manufacturer’s recommended intervals and whenever the test equipment is dropped or damaged. Calibration tags must be affixed to the test equipment or certificates readily available.
4. The accuracy shall be directly traceable to the National Institute of Standards and Technology (NIST).
5. Calibrating standard shall be of better accuracy than that of the instrument tested.

E. Infrared Thermographic Scanner: Infrared scanning equipment shall be an AGA (or approved equal) thermovision set capable of viewing an entire bus or equipment assembly at one time and have a sensitivity of 0.2 degrees C with a liquid nitrogen reference.

F. Ground Resistance Tester: At a minimum insulation resistance testing shall be performed with a Biddle “Megger” or equal.

2.2 TEST REPORT

A. Provide Test Reports in accordance with NETA Acceptance Testing Specifications section 5.4.

B. The test report shall include the following:

1. Summary of project.
2. Description of equipment tested including a description of the equipment’s location.
3. Description of tests.
4. Test data.
5. Analysis and recommendations.
6. Description of modifications made to improve test results.

C. Test Data shall include the following:
   1. Identification of the testing organization.
   2. Equipment identification.
   3. Humidity, temperature, and other conditions that may affect the results of the tests and/or calibrations.
   4. Date of inspections, tests, maintenance, and/or calibrations.
   5. Identification of the testing technician.
   6. Indication of inspections, tests, maintenance, and/or calibrations to be performed and recorded.
   7. Indication of expected results when calibrations are to be performed.
   8. Indication of as-found and as-left results, as applicable.
   9. Sufficient spaces to allow all results and comments to be indicated.

PART 3 EXECUTION

3.1 **PREPARATION**

A. Verify that field conditions are acceptable and are ready for testing.

B. Verify a suitable and stable source of electrical power is available at test site.

C. Verify that all equipment is installed and ready for testing.

D. Do not test or operate equipment for any purpose until it has been fully installed and serviced in accordance with the manufacturer's instructions.

E. Notify the Architect of equipment which is disclosed by test as unsatisfactory and replace equipment or wiring furnished under the Contract which is disclosed by tests as unsatisfactory.

3.2 **EXECUTION**

A. Perform tests noted herein and specified elsewhere in Division 26 specifications and as noted below.

B. Perform the following performance verification tests to all electrical appliances, systems, and work.
   1. Continuity Tests:
      a. Test control, alarm, and temperature control low voltage circuits to verify continuity of wiring and connections.

      b. The entire installation shall be tested free from open and short circuits and improper grounds.

   2. Phasing Tests:
      a. Perform tests and checks necessary to establish proper phase relationship of connected equipment.

      b. Check connections to motor-driven equipment for proper motor rotation. Correct connections as required.

      c. Disconnect, prior to checks, any device which could be damaged by application of voltage or incorrect phase sequence.

   3. System Function Tests:
      a. Verify controls of system prior to start-up to assure proper performance.

      b. Verify proper operation of pushbuttons, hand switches, pilot lights, and other control devices.

      c. Verify control circuits and programs for proper sequence of operation and interlocking functions.

      d. Verify proper operation of sensing devices and alarms.

4. Test motors under load with ammeter readings taken for each phase and record rpm of motors at time. Test motors for correct direction of rotation. Run tests on all motors and verify proper overload devices have been installed. Test and record the following on motors and submit the specified number of copies to the Engineer for review:
   a. Motor No., Location, HP rating.
   b. Motor circuit protector setting and size.
   c. Fuse size. Heater size.
   d. Full load amperes.
   e. Running amperes.
   f. Rated voltage.
   g. Terminal operating voltage.

C. Perform Insulation System Resistance Tests where noted in Division 26 specifications. Test voltages shall be in accordance with manufacturer's published values. In the absence of manufacturer's data utilize NETA ATS Table 100.1.

D. Perform thermographic Survey where noted in Division 26 specifications
   1. Perform thermographic survey in accordance with NETA ATS Section 9.
   2. Perform survey with system energized and load applied.
   3. Remove covers prior to commencing thermographic inspection.
   4. Perform survey during periods of maximum loading.

3.3 DOCUMENTATION

A. Provide written certificate(s) and include a copy with the O&M manuals, indicating that the inspections and tests specified herein have been performed.

B. Provide test reports as specified above in Part 2.

END OF SECTION

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SECTION 26 09 23 - LIGHTING CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Occupancy sensors
B. Manual control components
C. Network lighting control processors
D. Daylighting controls

1.2 RELATED REQUIREMENTS

A. Section 25 36 26 - Integrated Automation Lighting Relays.
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
C. Section 26 05 29 - Hangers and Supports for Electrical Systems
D. Section 26 05 33.16 - Boxes for Electrical Systems.
E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
F. Section 26 05 73 - Power System Studies.
G. Section 26 09 18 - Remote Control Switching Devices: Remotely controlled devices for lighting control, including networked lighting controls, programmable relay panels, and remote control switching relays.
H. Section 26 09 43 - Network Lighting Controls - Lutron QS/Quantum.
I. Section 26 27 26 - Wiring Devices:
    1. Includes finish requirements for wall controls specified in this section.
    2. Includes accessory receptacles, single-pole single-throw switches, and wall plates, to match lighting controls specified in this section.
J. Section 26 28 13 - Fuses.
K. Section 26 29 13 - Enclosed Controllers : General purpose contactors.
L. Section 26 51 00 - Interior Lighting.
M. Section 26 55 61 - Theatrical Lighting: Controls for stage lighting units.
N. Section 26 56 00 - Exterior Lighting.

1.3 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 Administrative Requirements

A. Coordination:
    1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
    2. Coordinate the placement of wall switch/dimmer occupancy sensors with actual installed door swings.
    3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
    4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
    5. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

B. Sequencing:
   1. Do not install lighting control devices until final surface finishes and painting are complete.

1.5 Submittals

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
C. Shop Drawings:
   1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.
   2. Daylighting Controls: Provide lighting plan indicating location, model number, and orientation of each photo sensor and associated system component.

1.6 Submittals for Closeout

A. Submit according to the requirements of Division 01 and Section 26 0100.
B. As-Built Drawings: include as-built drawings showing final locations, settings, and circuit arrangements of all devices included in this section.
C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
D. Operation and Maintenance Manuals:
   1. Approved and edited copy of Submittals for Review shall be included in the Operation and Maintenance Manuals.
   2. Include copies of all documentation required by part 3 of this specification with the Operation and Maintenance Manual.
   3. Provide System User’s Guide and Programmer’s Guide in electronic pdf format for the following equipment:
      a. Lighting control panel.
      b. Distributed digital lighting control system.
   4. Provide a digital copy of the final lighting control system programming on a CD or USB flash drive.
   5. Provide current licenses, and backup copies of the software for the Owner's records.
   6. Training Video: The contractor shall provide a complete training video for installation of software, basic operation of software, and common components of system.

1.7 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.
B. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.8 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 Warranty

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Provide five year manufacturer warranty for all occupancy sensors.
C. Provide five year manufacturer warranty for utility grade locking receptacle-mounted outdoor photo controls.
D. Provide two year manufacturer warranty for all daylighting controls.

PART 2 PRODUCTS

2.1 System Capabilities

A. Provide a full lighting control system. General system types to be used on this project are:
   1. Network lighting control system: low-voltage individually-addressable lighting controls connected using a full-building network controller. All devices connected to the network system must be individually addressable and controllable via the network; standalone control components may not be connected to or integrated with the network.
   2. Wireless lighting controls are required. The provided wireless control system must be fully-featured, match the capabilities of, and integrate with the installed non-wireless lighting control system. Wireless control components may not be battery powered, except for wall switches/dimmers without integrated sensors.

2.2 MANUFACTURERS

A. Acuity Brands Lighting:
   1. nLight Air
B. Leviton:
   1. GreenMAX DRC
C. Bubblynet
D. Legrand: Wattstopper DLM
E. Cooper Controls:
   1. WaveLinx Wireless
F. Lutron Electronics:
   1. Vive

2.3 manual control components

A. Single Pole Single Throw (SPST) Switches: refer to Section 26 27 26.
B. Wall Dimmers and Scene Controllers
   1. General Requirements:
      a. Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.

      b. Finish: Match finishes specified for wiring devices in Section 26 27 26, unless otherwise indicated.

   2. Control Type:
      a. Networked: Digital fade type with tap on/off, dimming, and preset scene control where indicated. Laser-engraved legends. Unmarked buttons are not acceptable. Powered via network communication bus.

      b. Wireless: Digital fade type with tap on/off, dimming, and preset scene control where indicated. Laser-engraved legends. Unmarked buttons are not acceptable. Refer to Part 2.01 for requirements for powering wireless components.

C. Digital Switches
   1. Finish: Match finishes specified for wiring devices in Section 26 27 26, unless otherwise indicated.

2. Control: Digital fade type with separated tap on/off. Laser-engraved legends. Unmarked buttons are not acceptable.

2.4 Occupancy Sensors

A. General Requirements

1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
2. Sensor Technologies:
   a. Passive Infrared (PIR) Occupancy Sensors: Designed to detect occupancy by sensing movement of thermal energy between zones.

   b. Ultrasonic Occupancy Sensors: Designed to detect occupancy by sensing frequency shifts in emitted and reflected inaudible sound waves.

   c. Microphonic Occupancy Sensors: Designed to detect occupancy by passively sensing frequencies associated with human activity.

3. Connection/Communication Technologies:
   a. Network-connected sensors: low-voltage, individually-addressable units for use with separate network-controlled accessory power packs or networked luminaires with integrated conrol modules.

   b. Wireless sensors: sensors using an approved manufacturer's standard communication technology to communicate with other elements of the lighting control system. Refer to Part 2.01 for requirements for powering wireless components.

4. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
5. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
6. Turn-Off Delay: Field adjustable, with time delay settings up to 20 minutes.
7. Sensitivity: Field adjustable.
8. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
9. Integral Photocell: For field selectable and adjustable inhibition of automatic turn-on of load when ambient lighting is above the selected level.
10. Compatibility (Non-Dimming Sensors): Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
11. Load Rating for Line Voltage Occupancy Sensors: As required to control the load indicated on drawings.
12. Load Rating for Line Voltage Occupancy Sensors:
    a. Motor Load: Not less than 1/6 HP.

B. Wall Switch/Dimmer Occupancy Sensors

1. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integral manual control capability, and no leakage current to load in off mode.
2. Capable of detecting motion within an area of 900 square feet.
3. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
4. Finish: Match finishes specified for wiring devices in Section 26 27 26, unless otherwise indicated.

5. Provide vandal resistant lenses for wall switch occupancy sensors where indicated.
6. Switch Type:
   a. Provide units with a second set of contacts to control minor motor loads along with lighting.

7. Dimmer Type:
   a. Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, and listed as complying with UL 1472; type and rating suitable for load controlled.

   b. Provide field adjustable dimming preset for occupied state.

   c. Provide fade-to-off operation to notify occupant of impending load turn-off.

C. Ceiling Mounted Occupancy Sensors
1. Description: Low profile occupancy sensors designed for ceiling installation.
2. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
3. Finish: White, unless otherwise indicated.
4. Standard Range Sensors: Capable of detecting motion within an area of 450 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.
5. Extended Range Sensors: Capable of detecting motion within an area of 1,200 square feet at a mounting height of 9 feet, with a field of view of 360 degrees.

2.5 Daylighting controls

A. Description: Control system consisting of low-voltage photo sensors and compatible control modules, power packs, contactors, or relays as required for automatic control of load indicated according to available natural light; capable of integrating with occupancy sensors and manual override controls.

B. Operation: Unless otherwise indicated, specified daylight zones shall be continuously dimmed or brightened in response to available daylight to meet target illuminance values as determined during system commissioning. Load to be turned off when available daylight is sufficient to fully dim the load, after the selected time delay.

C. Daylighting Control Photo Sensors: Low voltage class 2 photo sensor units with output signal proportional to the measured light level and provision for zero or offset based signal.
1. May be combined with occupancy sensors in a single housing.
2. Sensor Type: Filtered silicon photo diode.
3. Sensor Range:
   a. Indoor Photo Sensors: 5 to 100 footcandles.

   b. Outdoor Photo Sensors: 5 to 250 footcandles.

4. Finish: White unless otherwise indicated.

D. Daylighting Control Dimming Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors and with specified dimming drivers, for both continuous dimming of compatible dimming drivers and switching of compatible power packs, contactors, or relays in response to changes in measured light levels according to selected settings.
1. Dimming and Fade Rates: Adjustable from 5 to 60 seconds.
2. Cut-Off Delay: Selectable and adjustable from 0 to 20 minutes.
3. Output Voltage: Compatible with specified drivers.

2.6 Network Lighting Control Processor

A. General Requirements

B. Web-accessible, network connected, programmable control processor using manufacturer's software, manufacturer's software applications, and industry drivers to work with manufacturer's entire line of lighting controls. SNMP support, with built-in firewall, NAT, and router. Provide a communication / control bus providing power as required or manufacturer's network devices.
   1. Software shall be resident within the lighting control system.
   2. System shall provide local access to all programming functions at the control processor and remote access to all programming functions through any standard computer workstation connected to the building network. Lighting control system shall have the capability to be remotely controlled via the internet and/or building wide Ethernet LAN.
   3. At any time, should the remote PC go offline all system programming uploaded to the lighting control system shall continue to operate as intended. Systems dependent on an always-online PC or server for normal operation are not acceptable.
   4. All programs, schedules, time of day, etc, shall be held in non-volatile memory for an indefinite time exceeding 10 years in the event of power failure. At restoration of power, lighting control system shall implement programs required by current time and date. Time of day shall be battery backed for at least 10 years.

C. Network connection: provide connection to building owner's Local Area Network via CAT6 cable; coordinate connection location and security requirements with owner's IT staff.

D. Mount in surface enclosure provided by manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.

F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.

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

3.2 PREPARATION

A. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of lighting control devices provided under this section.
   1. Mounting Heights: As indicated on the drawings.
   2. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.
   3. Locate wall controls on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Engineer to obtain direction prior to proceeding with work.

C. Install lighting control devices in accordance with manufacturer's instructions.

D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

E. Install lighting control devices plumb and level, and held securely in place.

F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 27 26.

G. Provide required supports in accordance with Section 26 05 29.

H. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

I. Program controls in each room and verify that they function correctly. Failure of the programming will require a call back to correct the program.

J. Program the lighting controls once each area is ready for occupancy or after each phase has been completed.

K. Identify lighting control devices in accordance with Section 26 05 53.

L. Occupancy Sensor Locations:

1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.
2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.

M. Daylighting Control Photo Sensor Locations:

1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for proper control of respective room or area based on manufacturer's recommendations for installed devices.
2. Unless otherwise indicated, locate photo sensors for closed loop systems to accurately measure the light level controlled at the designated task location, while minimizing the measured amount of direct light from natural or artificial sources such as windows or pendant luminaires.
3. Unless otherwise indicated, locate photo sensors for open loop systems to accurately measure the level of daylight coming into the space, while minimizing the measured amount of lighting from artificial sources.

N. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.

O. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.

P. Unless otherwise indicated, install switches on load side of power packs so that switch does not turn off power pack.

Q. Where indicated or required, provide cabinet or enclosure in accordance with Section 26 05 33.16 for mounting of lighting control device system components.

3.4 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Engineer.

C. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.

D. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as indicated or as directed by Architect. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Engineer.

3.5 COMMISSIONING

A. See Section 01 91 13 - General Commissioning Requirements for commissioning requirements.

3.6 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

C. Demonstration: Once each area is ready for occupancy or after each phase has been completed, demonstrate proper operation of lighting control devices to Owner and Engineer, and correct deficiencies or make adjustments as directed.

D. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of the installed lighting control devices.
4. Location: At project site.
5. Provide any reprogramming, readjusting and training of the lighting control system within one year after occupancy.

END OF SECTION

SECTION 26 21 00 - LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical service requirements.

1.2 DEFINITIONS

A. Service Point: The point of connection between the facilities of the serving utility and the premises wiring as defined in NFPA 70, and as designated by the Utility Company.

1.3 REFERENCE STANDARDS

A. IEEE C2 - National Electrical Safety Code(R) (NESC(R)); 2023.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

A. No later than two weeks following date of the Agreement, notify Utility Company of anticipated date of service.
B. Coordination:
   1. Verify the following with Utility Company representative:
      a. Utility Company requirements, including division of responsibility.
      b. Exact location and details of utility point of connection.
      c. Utility easement requirements.
      d. Utility Company charges associated with providing service.
   2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for electrical service and associated equipment.
   3. Coordinate arrangement of service entrance equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
C. Arrange for Utility Company to provide permanent electrical service. Prepare and submit documentation required by Utility Company.
D. Utility Company charges associated with providing permanent service to be paid by Owner.
E. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Utility Company representative.
F. Scheduling:
   1. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.5 QUALITY ASSURANCE

A. Comply with the following:
   1. IEEE C2 (National Electrical Safety Code).
   2. NFPA 70 (National Electrical Code).
   3. The requirements of the Utility Company.

PART 2 PRODUCTS

2.1 ELECTRICAL SERVICE REQUIREMENTS

A. Provide new electrical service consisting of all required conduits, conductors, equipment, metering provisions, supports, accessories, etc. as necessary for connection between Utility Company point of supply and service entrance equipment.

B. Electrical Service Characteristics: As indicated on drawings.

C. Division of Responsibility:

1. Pad-Mounted Utility Transformers:

a. Transformer Pads: Furnished and installed by Contractor per Utility Company requirements.

b. Transformers: Furnished and installed by Utility Company.

c. Transformer Grounding Provisions: Furnished and installed by Contractor per Utility Company requirements.

d. Primary:

1) Trenching and Backfilling: Provided by Utility Company.

2) Conduits: Furnished by Utility Company and installed by Contractor.

3) Conductors: Furnished and installed by Utility Company.

e. Secondary:

1) Trenching and Backfilling: Provided by Contractor.

2) Conduits: Furnished and installed by Contractor.

3) Conductors: Furnished and installed by Contractor (Service Point at transformer).

2. Terminations at Service Point: Provided by Utility Company.

3. Metering Provisions:

a. Meter Bases: Furnished and installed by Contractor per Utility Company requirements.

b. Metering Compartments in Service Entrance Equipment: Furnished and installed by Contractor per Utility Company requirements.

c. Metering Transformers: Furnished and installed by Utility Company.

d. Conduits Between Metering Transformers and Meters: Furnished and installed by Contractor per Utility Company requirements.

e. Wiring Between Metering Transformers and Meters: Furnished and installed by Utility Company.

D. Products Furnished by Contractor: Comply with Utility Company requirements.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions and Utility Company requirements.

B. Perform work in accordance with NECA 1 (general workmanship).
C. Arrange equipment to provide minimum clearances and required maintenance access.
D. Provide required support and attachment components in accordance with Section 26 05 29.
E. Provide grounding and bonding for service entrance equipment in accordance with Section 26 05 26.
F. Identify service entrance equipment, including main service disconnect(s) in accordance with Section 26 05 53.

END OF SECTION

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SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General purpose transformers.

1.2 REFERENCE STANDARDS

A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; Current Edition.

B. 10 CFR 431, Subpart K. - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; DOE 2016.

C. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type Distribution and Power Transformers; 2015.

D. IEEE C57.96 - IEEE Standard Guide for Loading Dry-Type Distribution and Power Transformers; 2013.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

F. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2015.

G. NEMA ST 20 - Dry-Type Transformers for General Applications; 2014.

H. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.

K. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with placement of supports, anchors, etc. required for mounting.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.4 SUBMITTALS

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

B. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.

1.5 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

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

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB/GE: www.geindustrial.com/#sle.

B. Eaton Corporation: www.eaton.com/#sle.

C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

D. MGM Transformer Company.

E. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 TRANSFORMERS - GENERAL REQUIREMENTS

A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.

B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:

1. Altitude: Less than 3,300 feet.
2. Ambient Temperature:
   a. Greater than 10 kVA: Not exceeding 104 degrees F.
   b. Less than 10 kVA: Not exceeding 77 degrees F.

C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.

D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.

E. Basic Impulse Level: 10 kV.

F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

G. Isolate core and coil from enclosure using vibration-absorbing mounts.

H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.3 GENERAL PURPOSE TRANSFORMERS

A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.

B. Insulation System and Allowable Average Winding Temperature Rise:

1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.
2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.

C. Coil Conductors: Continuous aluminum or copper windings with terminations brazed or welded.

D. Winding Taps:

1. Less than 3 kVA: None.
2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.

3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.

E. Energy Efficiency: Comply with 10 CFR 431, Subpart K.

F. Sound Levels: Standard sound levels complying with NEMA ST 20

G. Mounting Provisions:

1. Less than 15 kVA: Suitable for wall mounting.
2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
3. Larger than 75 kVA: Suitable for floor mounting.

H. Transformer Enclosure: Comply with NEMA ST 20.

1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
2. Construction: Steel.
   a. Less than 15 kVA: Totally enclosed, non-ventilated.
   b. 15 kVA and Larger: Ventilated.
3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
4. Provide lifting eyes or brackets.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.

C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.

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

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

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

C. Install transformers in accordance with NECA 409 and IEEE C57.94.

D. Use flexible conduit, under the provisions of Section 26 05 33.13, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.

F. Install transformers plumb and level.

G. Transformer Support:

1. Provide required support and attachment in accordance with Section 26 05 29, where not furnished by transformer manufacturer.
2. Use integral transformer flanges, accessory brackets furnished by manufacturer, or field-fabricated supports to support wall-mounted transformers.
3. Unless otherwise indicated, mount floor-mounted transformers on properly sized minimum 3 inch high concrete pad constructed in accordance with Section 03 30 00.
4. Use trapeze hangers assembled from threaded rods and metal channel (strut) to support suspended transformers. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

H. Provide grounding and bonding in accordance with Section 26 05 26.

I. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.

J. Where not factory-installed, install lugs sized as required for termination of conductors as indicated.

3.3 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

END OF SECTION

SECTION 26 24 13 - SWITCHBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.

B. Overcurrent protective devices for switchboards.

1.2 RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

E. Section 26 43 00 - Surge Protective Devices.

1.3 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e, with Amendments (2022).

B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.

C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

D. NECA 400 - Standard for Installing and Maintaining Switchboards; 2007.

E. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

F. NEMA PB 2 - Deadfront Distribution Switchboards; 2011.

G. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less; 2013.

H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2017.

I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

K. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

L. UL 891 - Switchboards; Current Edition, Including All Revisions.

M. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Service Entrance Switchboards:

1. Coordinate with Utility Company to provide switchboards with suitable provisions for electrical service and utility metering, where applicable.
2. Coordinate with Owner to arrange for Utility Company required access to equipment for installation and maintenance.
3. Obtain Utility Company approval of switchboard prior to fabrication.
4. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.5 SUBMITTALS

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

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for switchboards, enclosures, overcurrent protective devices, and other installed components and accessories.

C. Shop Drawings: Indicate dimensions, voltage, bus ampacities, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.

1. Include dimensioned plan and elevation views of switchboards and adjacent equipment with all required clearances indicated.
2. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

D. Manufacturer's Installation 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.

E. Project Record Documents: Record actual installed locations of switchboards and final equipment settings.

F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

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

1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Enclosure Keys: Two of each different key.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.

B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.

C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Switchboards:

1. ABB/GE: www.geindustrial.com/#sle.
2. Eaton Corporation: www.eaton.com.
3. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
4. Siemens Industry, Inc: www.usa.siemens.com/#sle.

B. Source Limitations: Furnish switchboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 SWITCHBOARDS

A. Provide switchboards consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.

D. Service Entrance Switchboards:

1. Listed and labeled as suitable for use as service equipment according to UL 869A.
2. For solidly-grounded wye systems, provide factory-installed main bonding jumper between neutral and ground busses, and removable neutral disconnecting link for testing purposes.
3. Comply with Utility Company requirements for electrical service.
4. For service entrance boards rated 1000A and higher, provide GFCI protection for the main overcurrent protection device.

E. Service Conditions:

1. Provide switchboards and associated components suitable for operation under the following service conditions without derating:
   a. Altitude: Less than 6,600 feet.

   b. Ambient Temperature:

      1) Switchboards Containing Molded Case or Insulated Case Circuit Breakers: Between 23 degrees F and 104 degrees F.

2. Provide switchboards and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

F. Short Circuit Current Rating:

1. Provide switchboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

G. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.

H. Bussing: Sized in accordance with UL 891 temperature rise requirements.

1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.
2. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
3. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
4. Phase and Neutral Bus Material: Aluminum.
5. Ground Bus Material: Aluminum.

I. Conductor Terminations: Suitable for use with the conductors to be installed.

J. Enclosures:

1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: Type 1 or Type 2 (drip-proof).

2. Finish: Manufacturer's standard unless otherwise indicated.

K. Future Provisions:

1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
2. Equip distribution sections with full height vertical bussing to accommodate maximum utilization of space for devices.

L. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00, list switchboards as a complete assembly including surge protective device.

M. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

N. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time per NEC 240.87.

O. Arc Flash Energy-Reducing Maintenance Switching: For fuses rated 1200 A or higher, provide a fuse with a clearing time of 0.07 seconds or less at the available arcing current or a local switch with status indicator light that permits selection of a maintenance mode for reduced fault clearing time per NEC 240.67.

P. Instrument Transformers:
1. Comply with IEEE C57.13.
2. Select suitable ratio, burden, and accuracy as required for connected devices.
3. Current Transformers: Connect secondaries to shorting terminal blocks.
4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

2.3 OVERCURRENT PROTECTIVE DEVICES

A. Circuit Breakers:
1. Interrupting Capacity:
a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.

b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

2. Molded Case Circuit Breakers:
a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

1) Provide thermal magnetic circuit breakers for circuit breaker frame sizes less than 400 amperes.

2) Provide electronic trip circuit breakers for circuit breaker frame sizes 400 amperes and above.

b. Minimum Interrupting Capacity:

1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.

2) 20,000 rms symmetrical amperes at 480 VAC.

c. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.

d. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.

1) Provide the following field-adjustable trip response settings:

a) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.

b) Long time delay.

c) Short time pickup and delay.

d) Instantaneous pickup.

e) Ground fault pickup and delay where ground fault protection is indicated.

2) Provide zone selective interlocking capability where indicated, capable of communicating with other electronic trip circuit breakers and external ground fault sensing systems to control short time delay and ground fault delay functions for system coordination purposes.

3) Provide communication capability where indicated: Compatible with system indicated.

e. The ground fault protection system: shall be performance tested when first installed on site. This testing shall be conducted by a qualified person(s) using a test process of primary current injection, in accordance with instructions that shall be provided with the equipment. A written record of this testing shall be made and shall be available to the authority having jurisdiction.

f. Ground Fault Protection: integrally mounted relay and trip unit with adjustable pickup and time-delay setting, push-to-test feature, and ground-fault indicator. Zero sequence; adjustable ground fault sensitivity from 200 to 1200 amperes, time delay 0.1 to 0.4 seconds. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches.

g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive switchboards.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

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

B. Install switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.

C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.

D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 1/2 inch between switchboard and wall.

E. Provide required support and attachment in accordance with Section 26 05 29.

F. Install switchboards plumb and level.

G. Unless otherwise indicated, mount switchboards on properly sized minimum 4 inch high concrete pad constructed in accordance with Section 03 30 00.

H. Provide grounding and bonding in accordance with Section 26 05 26.

I. Install all field-installed devices, components, and accessories.

J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

K. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

L. Provide filler plates to cover unused spaces in switchboards.

M. Identify switchboards in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

C. Before energizing switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.

D. Inspect and test in accordance with NETA ATS, except Section 4.

E. Perform inspections and tests listed in NETA ATS, Section 7.1.

F. Molded Case and Insulated Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers. Tests listed as optional are not required.

G. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

1. Perform inspections and tests listed in NETA ATS, Section 7.14. The insulation-resistance test on control wiring listed as optional is not required.

H. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.

I. Correct deficiencies and replace damaged or defective switchboards or associated components.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of switchboard covers and doors.

3.5 CLEANING

A. Clean dirt and debris from switchboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred surfaces to match original factory finish.

END OF SECTION

SECTION 26 24 16 - PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Power distribution panelboards.
B. Lighting and appliance panelboards.
C. Overcurrent protective devices for panelboards.

1.2 REFERENCE STANDARDS

A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e, with Amendments (2022).
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NECA 407 - Standard for Installing and Maintaining Panelboards; 2015.
D. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
E. NEMA PB 1 - Panelboards; 2011.
F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 1000V or Less; 2023.
G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
J. UL 67 - Panelboards; Current Edition, Including All Revisions.
K. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
L. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.
M. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
N. UL 1053 - Ground-Fault Sensing and Relaying Equipment; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
   4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.

C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of panelboards and adjacent equipment with all required clearances indicated.
   2. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.

D. Manufacturer's Installation 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.

E. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Panelboard Keys: Two of each different key.

1.5 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB/GE: www.geindustrial.com/#sle.

B. Eaton Corporation: www.eaton.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

D. Siemens Industry, Inc: www.usa.siemens.com.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled as suitable for the purpose intended.

B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature:
      a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

C. Short Circuit Current Rating:
   1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
   1. For service entrance boards rated 1000A and higher, provide GFCI protection for the main breaker.

E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

G. Bussing: Sized in accordance with UL 67 temperature rise requirements.

1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.

H. Conductor Terminations: Suitable for use with the conductors to be installed.

I. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: Type 1.

2. Boxes: Galvanized steel unless otherwise indicated.
   a. Provide wiring gutters sized to accommodate the conductors to be installed.

3. Fronts:
   a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.

   b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.

   c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.

4. Lockable Doors: All locks keyed alike unless otherwise indicated.

J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

K. Surge Protective Devices: Where factory-installed, internally mounted surge protective devices are provided in accordance with Section 26 43 00, list and label panelboards as a complete assembly including surge protective device.

L. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.

1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.

M. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.

N. Load centers are not acceptable.

2.3 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:

1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:

1. Phase and Neutral Bus Material: Aluminum or copper.
2. Ground Bus Material: Aluminum or copper.

D. Circuit Breakers:

1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.

E. Enclosures:

1. Provide surface-mounted or flush-mounted enclosures unless otherwise indicated.
2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:
1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
2. Main and Neutral Lug Type: Mechanical.

C. Bussing:
1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
2. Phase and Neutral Bus Material: Aluminum or copper.
3. Ground Bus Material: Aluminum or copper.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:
1. Provide surface-mounted or flush-mounted enclosures as indicated.
2. Fronts: Provide lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:
1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. Interrupting Capacity:
a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:

1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.

2) 20,000 rms symmetrical amperes at 480 VAC.

b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

3. Conductor Terminations:
a. Provide mechanical lugs unless otherwise indicated.

b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
a. Provide the following field-adjustable trip response settings:

1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.

2) Long time delay.

3) Short time pickup and delay.

4) Instantaneous pickup.

5) Ground fault pickup and delay where ground fault protection is indicated.

6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
7. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time per NEC 240.87.
8. Provide the following circuit breaker types where indicated:
   a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
9. Do not use tandem circuit breakers.
10. Do not use handle ties in lieu of multi-pole circuit breakers.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive panelboards.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
E. Provide required support and attachment in accordance with Section 26 05 29.
F. Install panelboards plumb.
G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
I. Mount floor-mounted power distribution panelboards on properly sized minimum 3 inch high concrete pad constructed in accordance with Section 03 30 00.
J. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
K. Provide grounding and bonding in accordance with Section 26 05 26.
L. Install all field-installed branch devices, components, and accessories.
M. Set field-adjustable circuit breaker tripping function settings as indicated.
N. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
O. Provide filler plates to cover unused spaces in panelboards.
P. Identify panelboards in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

C. Test GFCI circuit breakers to verify proper operation.

D. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust alignment of panelboard fronts.

C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.5 CLEANING

A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 27 26 - WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Wall switches.
B. Receptacles.
   1. Straight blade receptacles.
   2. GFCI type receptacles.
C. Wall plates.
D. Floor box service fittings.
E. Cord and Plug Sets
F. Device plates and decorative box covers

1.2 REFERENCE STANDARDS

A. FS W-C-596 - Connector, Electrical, Power, General Specification for; 2014h (Validated 2022).
B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification); 2017g (Validated 2023).
C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
E. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2015).
F. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2016.
G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
H. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
I. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
K. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
   2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
   3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
   4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
   5. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.
B. Sequencing:
   1. Do not install wiring devices until final surface finishes and painting are complete.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

1.5 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.1 WIRING DEVICE APPLICATIONS

A. Provide wiring devices suitable for intended use and with ratings adequate for load served.

B. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.

C. Provide tamper resistant 15 and 20 ampere, 125 and 250 volt receptacles installed in the following areas and/or building types:

1. Preschools and education facilities

D. Provide GFCI protection for receptacles installed within 6 feet of sinks.

E. Provide GFCI protection for receptacles installed in kitchens.

F. Provide GFCI protection for receptacles serving electric drinking fountains.

G. Unless noted otherwise, do not use combination switch/receptacle devices.

2.2 WIRING DEVICE FINISHES

A. Provide wiring device finishes as described below unless otherwise indicated.

B. Wiring Devices, Unless Otherwise Indicated: White with white nylon wall plate.

2.3 WALL SWITCHES

A. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.

B. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.4 RECEPTACLES

A. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.

1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
2. NEMA configurations specified are according to NEMA WD 6.

B. Convenience Receptacles:

1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
2. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SD suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
3. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.

C. GFCI Receptacles:

1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.

2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.

2.5 WALL PLATES

A. Wall Plates: Comply with UL 514D.
   1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
   2. Size: Standard.
   3. Screws: Metal with slotted heads finished to match wall plate finish.

B. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.

C. Stainless Steel Wall Plates : Brushed satin finish, Type 302 stainless steel.

D. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.

E. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

2.6 FLOOR BOX SERVICE FITTINGS

A. Description: Service fittings compatible with floor boxes provided under Section 26 05 33.16 with components, adapters, and trims required for complete installation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.

C. Verify that wall openings are neatly cut and will be completely covered by wall plates.

D. Verify that final surface finishes are complete, including painting.

E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

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

3.2 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.

B. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of wiring devices provided under this section.
   1. Mounting Heights: Unless otherwise indicated, as follows:
      a. Wall Switches: 48 inches above finished floor.
      b. Wall Dimmers: 48 inches above finished floor.
      c. Fan Speed Controllers: 48 inches above finished floor.
      d. Receptacles: 18 inches above finished floor or 6 inches above counter. Modify receptacle installation height to accomodate hydronic baseboard heat where installed.
   2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
   3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.

4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Engineer to obtain direction prior to proceeding with work.
5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.

C. Install wiring devices in accordance with manufacturer's instructions.

D. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

E. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

F. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

G. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

H. Unless otherwise indicated, GFCI receptacles may be connected to provide feed-through protection to downstream devices. Label such devices to indicate they are protected by upstream GFCI protection.

I. Install wiring devices plumb and level with mounting yoke held rigidly in place.

J. Install wall switches with OFF position down.

K. Install vertically mounted receptacles with grounding pole on bottom and horizontally mounted receptacles with grounding pole on right.

L. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

M. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect each wiring device for damage and defects.

C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.

D. Test each receptacle to verify operation and proper polarity.

E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.

F. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.4 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Engineer.

END OF SECTION

SECTION 26 28 16.16 - ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Enclosed safety switches.

1.2 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
C. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
E. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
F. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
G. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of enclosed switches and adjacent equipment with all required clearances indicated.
   2. Include wiring diagrams showing all factory and field connections.
D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.5 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. ABB/GE: www.geindustrial.com/#sle.

B. Eaton Corporation: www.eaton.com.

C. Schneider Electric; Square D Products: www.schneider-electric.us.

D. Siemens Industry, Inc: www.usa.siemens.com.

2.2 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:

1. Altitude: Less than 6,600 feet.
2. Ambient Temperature: Between -22 degrees F and 104 degrees F.

D. Horsepower Rating: Suitable for connected load.

E. Voltage Rating: Suitable for circuit voltage.

F. Short Circuit Current Rating:

1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.

G. Provide with switch blade contact position that is visible when the cover is open.

H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.

1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.

I. Conductor Terminations: Suitable for use with the conductors to be installed.

J. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

K. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.

1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
   a. Indoor Clean, Dry Locations: Type 1.
   b. Outdoor Locations: Type 3R.

L. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

M. Heavy Duty Switches:

1. Comply with NEMA BS 31047.
2. Conductor Terminations:
   a. Provide mechanical lugs unless otherwise indicated.
   b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.

3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive enclosed safety switches.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Perform work in accordance with NECA 1 (general workmanship).
C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
D. Provide required support and attachment in accordance with Section 26 05 29.
E. Install enclosed switches plumb.
F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
G. Provide grounding and bonding in accordance with Section 26 05 26.
H. Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
I. Identify enclosed switches in accordance with Section 26 05 53.

3.3 CLEANING

A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

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SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Interior luminaires.
B. Emergency lighting units.
C. Exit signs.
D. Drivers.

1.2 REFERENCE STANDARDS

A. IES LM-63 - IESNA Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002 (Reaffirmed 2008).
B. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.
C. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; 2015, with Errata (2017).
D. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; 2006.
E. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; 2006.
F. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2012.
G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
H. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
I. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
J. UL 1598 - Luminaires; Current Edition, Including All Revisions.
K. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
   2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
   3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
   4. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
   2. Provide photometric calculations where luminaires are proposed for substitution upon request.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
   1. LED Luminaires:
      a. Include estimated useful life, calculated based on IES LM-80 test data.
   2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IES LM-63 standard format upon request.

D. Manufacturer's Installation 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.

E. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

1.5 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.6 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

2.2 LUMINAIRES

A. Provide products as scheduled.

B. Provide products that comply with requirements of NFPA 70.

C. Provide products that are listed and labeled as complying with UL 1598, where applicable.

D. Provide products listed, classified, and labeled as suitable for the purpose intended.

E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

H. Recessed Luminaires:
   1. Ceiling Compatibility: Comply with NEMA LE 4.
   2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
   3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

I. LED Luminaires:
   1. Components: UL 8750 recognized or listed as applicable.
   2. Tested in accordance with IES LM-79 and IES LM-80.
   3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

J. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.3 EXIT SIGNS

A. Description: Exit signs complying with NFPA 101 and applicable state and local codes, and listed and labeled as complying with UL 924.
   1. Number of Faces: Single- or double-face as indicated or as required for installed location.
   2. Directional Arrows: As indicated or as required for installed location.

B. Powered Exit Signs: Internally illuminated with LEDs unless otherwise indicated.
   1. Self-Powered Exit Signs:
      a. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

      b. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

      c. Provide low-voltage disconnect to prevent battery damage from deep discharge.

2.4 **DRIVERS**

A. Ballasts/Drivers - General Requirements:
   1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
   2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.
   3. Driver shall be required for have isolated grounds between 0-10V dimming connection and 277/120V connection built into driver. Drivers with shared grounds shall not be accepted.

B. Dimmable LED Drivers:
   1. Dimming Range: Continuous dimming from 100 percent to ten percent relative light output unless dimming capability to lower level is indicated, without flicker.
   2. Input Voltage: Suitable for operation at voltage of connected source, with variation tolerance of plus or minus 10 percent.
   3. Total Harmonic Distortion: Not greater than 20 percent.
   4. Power Factor: Not less than 0.90.
   5. Surge Protection: ANSI 62.41 Category A, 4kV line to neutral.
   6. Driver shall be required to have isolated grounds between 0-10V dimming connection and 277/120V connection built into driver. Drivers with shared grounds shall not be accepted.
   7. Control Compatibility: Fully compatible with the dimming controls to be installed. See Section 26 09 23.

PART 3 EXECUTION

3.1 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.2 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.

B. 0-10V or low voltage dimming wire shall not be run in same conduit as 120/277V power connection to fixture.

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

D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).

E. Provide required support and attachment in accordance with Section 26 05 29.

F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

G. Suspended Ceiling Mounted Luminaires:

1. Do not use ceiling tiles to bear weight of luminaires.
2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
4. Secure pendant-mounted luminaires to building structure.
5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gauge, connected from opposing corners of each recessed luminaire to building structure.
7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.

H. Recessed Luminaires:

1. Install trims tight to mounting surface with no visible light leakage.
2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.

I. Suspended Luminaires:

1. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
2. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet between supports.
3. Install canopies tight to mounting surface.
4. Unless otherwise indicated, support pendants from swivel hangers.

J. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

K. Install accessories furnished with each luminaire.

L. Bond products and metal accessories to branch circuit equipment grounding conductor.

M. Exit Signs:

1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.

N. Install lamps in each luminaire.

3.3 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Test self-powered exit signs, emergency lighting units, and fluorescent emergency power supply units to verify proper operation upon loss of normal power supply.

E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Engineer.

3.4 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.

B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Engineer or authority having jurisdiction.

C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Engineer or authority having jurisdiction.

3.5 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.6 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

3.7 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

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SECTION 26 56 00 - EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Exterior luminaires.
B. Ballasts.
C. Poles and accessories.

1.2 REFERENCE STANDARDS

A. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.
B. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; 2015, with Errata (2017).
C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
D. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems; 2006.
E. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2012.
F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
G. UL 1598 - Luminaires; Current Edition, Including All Revisions.
H. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
   2. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.4 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
   1. LED Luminaires:
      a. Include estimated useful life, calculated based on IES LM-80 test data.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

2.2 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.

H. Recessed Luminaires:

1. Ceiling Compatibility: Comply with NEMA LE 4.

I. LED Luminaires:

1. Components: UL 8750 recognized or listed as applicable.
2. Tested in accordance with IES LM-79 and IES LM-80.
3. LED Estimated Useful Life: Minimum of 50,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

2.3 BALLASTS AND DRIVERS

A. Ballasts/Drivers - General Requirements:

1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

2.4 POLES

A. All Poles:

1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

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

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.

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

C. Install luminaires in accordance with NECA/IESNA 501.

D. Provide required support and attachment in accordance with Section 26 05 29.

E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

F. Recessed Luminaires:

1. Install trims tight to mounting surface with no visible light leakage.
2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.

G. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

H. Install accessories furnished with each luminaire.

I. Bond products and metal accessories to branch circuit equipment grounding conductor.

J. Install lamps in each luminaire.

3.4 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect each product for damage and defects.

C. Operate each luminaire after installation and connection to verify proper operation.

D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Engineer.

3.5 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.

3.6 CLEANING

A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

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SECTION 27 00 00 - STRUCTURED CABLING GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical General Requirements specifically applicable to Division 27 Sections, in addition to Division 01 - General Requirements.

B. Definitions common to Division 27 specification sections.

1.2 RELATED DOCUMENTS

A. Drawings, addenda and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification Sections, apply to this and all other sections of Division 27.

B. This section is related to all other sections of 27.

1.3 DEFINITIONS

A. Words "Architect" where written in Division 27 specifications and drawings refer to commissioned Design Professional, whose name appears on contract documents.

B. Word "Engineer" where written in Division 27, specifications and drawings refers to Consulting Electrical Engineer, CMTA, Inc., 311 Fourth Street South, Suite #20, Grand Forks, ND, 58201; phone (701)775-2594.

C. Word "Contractor" where written in Division 27specifications and drawings refers to Electrical Contractor and any and all of his subcontractors.

D. Word "Material" where written in Division 27, specifications and drawings shall mean any and all apparatus, equipment, devices, fixtures, components, products, assemblies, items, parts, things, and any other pieces specified or shown or required.

E. Word "Labor" where written in Division 27 specifications and drawings shall mean any and all physical effort, manpower, time, expertise, tools, equipment and services to carefully assemble, install and affix all material in a proper, complete and acceptable manner.

F. Word "Provide" where written in Division 27 specifications and drawings shall mean "Electrical Contractor shall furnish all labor and material and completely and properly install such material and leave same in acceptable condition and intended acceptable working order".

G. Performance Verification Testing refers to test performed in the field to ensure proper operation and / or installation of service or products.

1. Unless noted otherwise Performance Verification Testing is not required to be provided by a 3rd party testing firm.
2. Unless noted otherwise Performance Verification Testing is not required to be witnessed by the Electrical Engineer, Owner, Architect, and / or (if applicable) Commissioning Agent

H. Acceptance Testing refers to formal testing process required prior to acceptance by the Owner.

1. Unless noted otherwise Acceptance Testing is not required to be provided by a 3rd party testing firm.
2. Unless noted otherwise Acceptance Testing is required to be witnessed by the Electrical Engineer, Owner, Architect, and / or (if applicable) Commissioning Agent.

I. As-built drawings are prepared by the contractor. They show, in red ink, on-site changes to the original construction documents.

J. Record drawings are prepared by the Architect or Engineer and reflect on-site changes the contractor noted in the as-built drawings.

K. Quality Assurance includes all the planned and systematic activities implemented that can be demonstrated to provide confidence that a product or service will fulfill requirements for quality. Typically, quality assurance procedures are performed before and while the work is being performed. As such in the Division 27, specifications Quality Assurance procedures are specified in Part 1.

L. Quality Control includes all the planned activities required to verify quality after the work has been performed. This can include testing and inspections along with other procedures. As such in the Division 27, specifications Quality Assurance procedures are specified in Part 3.

1.4 SCOPE OF WORK

A. All Specifications, corresponding Drawings and all Addenda form a complete set of documents for electrical work for this project, and no part shall be considered complete without the other.

B. The Specifications, Drawings, and all Addenda describe both the design characteristics and functional performance criteria that the completed telecommunications systems shall include.

C. Contractor shall obtain all required licenses, permits, plan reviews, inspections and pay all fees, costs and all other charges for this project. All sales, use and any other taxes shall be paid by Contractor.

D. Electrical Work shall comply with all ordinances, laws, regulations and codes applicable to the work involved. If, in any instance, the plans and specifications conflict with such laws, the stricter requirement shall take preference.

E. If Contractor is aware of conflicts between drawings or specifications and such codes or regulations, they shall be brought to the Engineer's attention prior to commencing work. If Contractor performs work in violation of such codes or regulations, Contractor shall correct the violation at his expense.

F. Work under Division 27, includes providing all labor and materials necessary for satisfactory completion of all electrical work shown on all drawings and in all specification divisions. In general, this consists of the following:

1. Telecommunications Systems.
2. Intercom Systems.
3. A/V Systems.

G. Site Investigation

1. Prior to submitting bids, visit the work site to become familiar with existing conditions which may affect the cost of the project. This includes measurements for lengths, quantities, clearances and all other field verifiable conditions.
2. No extra charges will be allowed because of failure of Contractor to become familiar with all existing conditions.
3. Where work under this project requires extension, relocation, or modifications to existing equipment, systems or installations the existing equipment, system or installations shall be restored to their original condition, with exception to the work under this project, before completion.
4. Existing equipment, systems and installations which are not detailed on the drawings must still be restored to their original condition.

1.5 ALTERNATES

A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the Owner's option. Accepted Alternates will be identified in Owner-Contractor Agreement (contract).

B. Coordinate related work and modify surrounding work as required.

C. Schedule of Alternates: See Division 00 and Division 01.

1.6 DRAWINGS

A. Drawings indicate the extent and general layout of the structured cabling systems.

B. The electrical drawings are diagrammatic (that is, designed to demonstrate or explain the scope of work), they are intended to be as accurate as planning can determine.

C. The scales are shown for estimating purposes only. Field verification of dimensions, locations, and construction details is required. Review appropriate drawings (for example: shop drawings), make field measurements and adjust work to suit the conditions encountered. Although electrical drawings are diagrammatic, they shall be followed as closely as actual construction permits.

D. Contractor shall coordinate with civil, architectural, structural, and mechanical construction drawings for locations of partitions, walls, beams, shafts, equipment, etc.

E. DO NOT SCALE LOCATIONS OF STRUCTURED CABLING OUTLETS OR OTHER DEVICES FROM ELECTRICAL DRAWINGS.

F. Standard electrical symbols along with special symbols are used on all drawings.

1.7 REGULATORY REQUIREMENTS

A. Work provided shall comply with the following partial list of governing codes and regulations:

1. International Building Code (IBC).
2. International Fire Code. (IFC).
3. State Fire Codes.
4. State and Local Electric Codes.
5. State Building Code.
6. Serving Utility Regulations.
7. National Fire Protection Association (NFPA) National Fire Codes.
   a. NFPA 70 - National Electrical Code.
   b. NFPA 72 - National Fire Alarm and Signaling Code.
   c. NFPA 101 - Life Safety Code.
8. Williams-Steiger (OSHA) Regulations.
9. Americans with Disabilities Act (ADA) requirements.
10. State Health Department Requirements

1.8 QUALITY ASSURANCE

A. Notify the Architect or Engineer of any discrepancies in or omissions from the drawings and documents. Interpretations and clarifications during bidding will be made only by written Addenda. If discrepancies are not reported, the contractor shall bid the greater quantity or better quality, and appropriate adjustment will be made after contract award.

B. Any work not clear to Contractor shall be referred to Architect or Engineer for clarification before bid is submitted. If no question is raised prior to opening of bid, Contractor shall be required to provide work, in question, as directed by Architect or Engineer, whose decision shall be final, without additional charges.

C. By virtue of submitting a bid, Contractor agrees that he is skilled and experienced in use of and in interpretation of drawings and specifications. Contractor further agrees that he has carefully reviewed all drawings, all specifications and all addenda, which constitute bid documents for this contract, and finds them free of ambiguities and good and sufficient for bidding and construction purposes.

D. Should major changes from drawings and specification be necessary, Contractor shall provide notification and secure written approval and agreement concerning such changes before work is started.

1.9 WARRANTY

A. The Electrical Contractor shall guarantee that all materials and equipment included in their work free of defects caused by flawed workmanship, material or equipment failures.

B. The warranty guarantee shall extend one year minimum from the date of final acceptance of the work or for as long as normal equipment manufacturer warranties are in effect from the date of final acceptance of the work.

C. During the warranty period, the Electrical Contractor shall respond by making appropriate corrections or repairs required to correct defect within one week of notification. Notification shall be made by telephone, fax, email, or letter.

D. The Electrical Contractor shall provide 24-hour service in case of emergency.

1.10 SUBSTITUTIONS

A. Where substitute materials or prior approved materials are provided, Contractor shall assume all responsibility and pay for all necessary changes resulting from such substitution. This responsibility shall also include any extra costs required by other trades.

B. Required where specifically noted or where materials are specifically identified by a manufacturer's name, model or catalog number. In these cases only such material may be included in base bid. Prior approval of substitute materials shall be required.

C. Prior approved substitutions:

1. Requests for prior approval shall be made in accordance with Division 01, as specified below, and indicated in specific specification section.
2. If Contractor desires to furnish materials other than that named, Contractor or supplier shall apply in writing, to Architect, for prior approval of such material at least ten (10) days prior to bid opening date.
3. Requests for prior approved substitution shall indicate specific proposed materials in lieu of those specified together with complete technical data for all such proposed material.
4. All prior approved substitutions will be clearly identified in addenda which will be sent to all bidders well in advance of bid opening. Only material listed on drawings, specifications and addenda shall be provided.

D. Substitutions after execution of contract: Substitution of materials other than those specifically named in contract documents will be approved, by Architect or Engineer, for following reason only:

1. That material proposed for substitution is equal to or superior, in Engineer and Architect's opinion, to that specified in construction, efficiency, appearance, and utility.
2. That material named in the documents cannot be delivered to project in time to complete work due to conditions beyond control of Contractor.

E. Equal To and Or Equal: Where materials are specifically identified as “equal to” an identified manufacturer’s name, model, or catalogue numbers or where noted as “or equal” manufacturer’s complying with the requirements of these specifications not listed may be incorporated in the Work. Such materials must be equal to or superior, in Engineer’s opinion, to that specified in construction, efficiency, appearance, and utility.

1.11 GENERAL REQUIREMENTS FOR SUBMITTALS

A. Submit according to the requirements of Division 01.

B. General requirements for Submittals for Review

1. Submittal format, general information, and requirements for all submittals:
   a. At the front of the submittal on a dedicated page(s): name, address, and phone number of equipment vendor, engineer, and contractor.

   b. At the front of the submittal on dedicated page(s): Any deviation from contract requirements shall be called to attention. No deviation will be permitted without written approval of Architect or Engineer.

   c. At the front of the submittal on dedicated page(s): Any requests for clarification, selections that must be made, etc. shall be called to attention.

   d. At the front of the submittal on a dedicated page(s): Include a complete list of equipment included with manufacturer and model number or catalog number.

   e. Submittals shall be grouped to include complete information for related systems, products, and accessories in a single submittal with tabs, dividers, or other means of separating each different component within the submittal from the next.

   f. Mark dimensions and values in units to match those specified.

g. Drawings and brochures shall be clearly marked as to item to be supplied and shall have designation corresponding to designation on Drawings (for example: enclosed switch data shall indicate for which equipment they are provided).

2. Contractor Review of Submittals
   a. The Contractor shall thoroughly review each item for compliance with these Specifications making any necessary corrections prior to issuing submittal. Each submittal set shall be stamped, signed and dated indicating Contractor review. If the Contractor fails to properly review submittals, the Contractor shall reimburse the Engineer for all additional reviews on a time and material basis.

   b. Should the contractor fail to comply with any of the requirements of the specified submittal requirements; then the right is reserved by the Architect or Engineer to select any or all items in the material schedule, with that selection to be final and binding upon the contractor. The materials selected or reviewed, as the case may be, by the Architect and / or Engineer, shall be used in the work at no additional cost to the Owner.

3. Architect / Engineer Review of Submittals
   a. The submittal will be reviewed with reasonable promptness, and returned to the Contractor (with copies retained by the Engineer and the Architect). No equipment should be released for shipment until submittals have been approved.

   b. Submittal review is to verify general conformance with the design concept of the Project and substantial compliance with the information provided in the Contract Documents. This review does not in any way relieve the Contractor or their suppliers of their responsibility to provide all materials and equipment as specified, in quantities, quality and dimensions required.

   c. Approval Stamp: Submittals will be reviewed with the following actions noted:

      1) “No Exception Taken” indicates that the Submittal appears to conform to the design concept of the Work and that the Contractor, at his discretion, may proceed with fabrication and/or procurement and installation.

      2) “Reviewed as Noted” indicates that the Submittal, after noted corrections are made, appears to conform to the design concept of the Work and that the Contractor, at his discretion, may proceed with fabrication and/or procurement and installation, if the corrections are accepted by the Contractor without an increase in Contract Sum or Time.

      3) “Revise and Resubmit” indicates that the noted revisions are such that a corrected copy of the Submittal is required for review to confirm that the noted revisions have been understood and made. The Contractor, at his discretion, may proceed with fabrication and/or procurement and installation after submitting a corrected copy and verifying with the reviewer that the corrected copy is acceptable, if the corrections are accepted by the Contractor without an increase in the Contract Sum or Time.

      4) “Rejected” indicates that the Submittal does not appear to conform to the specifications, a resubmission is required and fabrication or procurement is not authorized.

4. If the Architect or Engineer rejects (Revise and Resubmit or Rejected) the same section two times the engineer shall be compensated for additional reviews (beyond the first two) at a rate of $500 per review. Compensation will be incorporated by Change Order and will be deducted from the Contractor's application for payment. Contractor is responsible for all delays caused by the resubmittal process

C. General Requirements for Submittals For Information
   1. Information submittals shall include the information noted in the specifications and information requested by the Architect, Engineer, and / or Owner.
   2. Coordination Drawings: Where this and other specification sections require Coordination Drawings to be submitted meet the requirements defined in Division 01 and as indicated below.
      a. Prepare documents using software program required by Division 01. If no requirements are listed utilize a software compatible with AutoDesk's AutoCAD.
      b. Submit hardcopies and / or electronic copies as required by Division 01. Drawings and files shall be uniquely labeled.
      c. Scale shall not be less than 1/8" equal 1 foot.

D. General Requirements for Submittals for Closeout:
   1. As specified in Division 01 and Section 27 0100.

E. General Requirements for Product Data. The following are minimum requirements.
   1. Catalog sheets showing ratings, settings, performance curves and rated capacities.
   2. Dimensions, materials, fabrication details, finish.
   3. Outline and support point dimensions, arrangement and sizes, roughing-in data, and accessories.
   4. Operational Characteristics.

F. General Requirements for Shop Drawings. The following are minimum requirements.
   1. Electrical ratings of equipment; how the components of the equipment are assembled and function together; and how they will be installed on the project.
   2. Dimensioned plans, elevations, sections, and details. Show quantities of installed devices, features, and ratings.
   3. Detail enclosure types.
   4. Detail configuration, current, and voltage ratings.
   5. Detail features, characteristics, ratings, and factory settings devices and auxiliary components.
   6. Include wiring diagrams.

G. General Requirements for Manufacturer's Instructions. The following are minimum requirements.
   1. Application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements.
   2. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
   3. Instructions for placing each piece of equipment and system into operation.

1.12 **PROJECT SUBCONTRACTOR AND VALUES LISTING**

A. Contractor shall submit, to Architect, a list indicating brands of all major materials, names of all of his subcontractors and a schedule of values for this project. Engineer reserves right to reject any material or subcontractor and question scheduled values.

PART 2 PRODUCTS

2.1 Not Used.

PART 3 EXECUTION

3.1 Not Used.

END OF SECTION

SECTION 27 05 00 - COMMON WORK RESULTS FOR STRUCTURED CABLING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This Section includes limited scope general construction materials and methods for application with electrical, communications, and electronic safety and security systems installations.

B. Materials specified herein include:

1. Concrete.
2. Miscellaneous for support of structured cabling materials and equipment.
3. Hangers and Supports.
4. Joint sealers for sealing around structured cabling materials and equipment; and for sealing penetrations in walls, floors, ceilings, roofs, foundations for moisture, water, smoke, fire and acoustic control.

C. General electric construction methods and requirements specified herein include:

1. Material and workmanship.
2. Product manufacturer requirements.
3. Coordination.
4. Safety.
5. Material handling, storage protection, cleaning and painting.
6. Cutting, patching and finishing.
7. Penetrations.
8. Wiring Methods.
9. System Interruptions.
10. Outlet mounting heights.
11. Structured Cabling demolition and remodeling.
12. Equipment Wiring (connections).
13. Coordination with Telecommunications Company for permanent communication service, including payment of all Telecommunications Company charges for service.

D. Owner Instruction and Demonstration.

1.2 RELATED DOCUMENTS

A. Drawings, addenda and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification Sections, apply to this and all other sections of Division 27.

B. This section is related to all other sections of Division 27.

C. Division 03 Section Cast-in-Place Concrete (Miscellaneous Cast-in-Place Concrete).

D. Division 03 Section Grouting.

E. Division 03 Section Concrete Boring (Concrete Core Drilling).

F. Section 27 0100 Electrical Systems Close Out Documentation.

1.3 COMMUNICATION SERVICE DESCRIPTION

A. Serving Telecommunications Company: Garden Valley Telephone

B. System Characteristics: As indicated on drawings.

1.4 REGULATORY REQUIREMENTS

A. See Section 27 0000.

1.5 COMMON REQUIREMENTS FOR QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years experience.

B. Installer Qualifications: Engage experienced Installers for Work.

C. 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 re-certification.

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

E. Standardization of Product Manufacturer:

1. When two or more items of same material or equipment are required they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, wire, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in Work, except as otherwise indicated.
2. Wiring devices and other items covered under a single specification section, with the, shall be of the same manufacturer and style whenever practical or where failure to do so is visibly noticeable.

F. Material and Workmanship:

1. All materials provided shall be new and shall be approved by the Underwriters Laboratories, Inc., NFPA, NEMA, and ANSI as conforming to its standards in every case where such a standard has been established for such material.
2. Materials shall be standard products of manufacturer’s regularly engaged in the production of such equipment and shall be the manufacturer’s latest standard design.
3. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
4. All workmanship shall be neat and complete in both effectiveness and appearance and shall be executed by persons licensed and skilled in the trade. Engineer reserves the right to reject any material or workmanship before, during or after construction.
5. Materials and Finishes: Provide adequate corrosion resistance to eliminate staining of exposed surfaces.
6. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.

G. Coordination:

1. See also “Quality Assurance” paragraph of Section 27 0000.
2. Discrepancies and omissions discovered during construction shall immediately be called to the attention of the Architect or Engineer for clarification.
3. Installation of materials shall be coordinated with other trades and installed at such time and manner as to not delay or interfere with the work of other trades.
4. Obtain and review shop drawings, product data, manufacturer’s wiring diagrams, and manufacturer's instructions for equipment furnished under other sections. Determine connection locations and requirements.
5. Sequence and coordinate work with other trades so as to avoid conflict of space and time sequence. If interference develops, the matter shall be brought to the attention of the Architect for decision.
6. Organize the work so that progress of work will conform to the progress of other trades. Give particular attention to large equipment requiring positioning prior to closing the building.
7. Complete the entire installation as soon as building conditions permit.
8. This Contractor shall be held solely responsible for coordinating proper size and location of hangers, slots, chases, openings, etc., required for proper installation of his work and shall arrange with the proper building contractors for inserts, chases, and openings.
9. Refer to drawings and specifications of all other divisions and trades for correlating information, location and details of work, dimensions, etc. Coordinate location of all outlets and equipment. If conflicts develop Architect or Engineer’s decision will govern. No additional compensation will be allowed for moving of un-coordinated, misplaced or poorly located outlets, material, equipment or work.

H. Pre-installation meetings are required as noted in this and other specification sections and are intended to help coordination efforts. Structured Cabling Contractor shall schedule and convene a pre-installation meeting with all affected trades as noted in specifications and on Drawings.

I. Provide competent representative(s) on site constantly to supervise work from beginning through completion and final acceptance. So far as possible contractor shall keep same foreman and workmen throughout project duration.

J. During its progress, the work shall be subject to observation by representatives of Owner, Architect and Engineer at which times Contractor shall furnish all required information and cooperation

1.6 **SAFETY**

A. Comply with the requirements of Division 01 and this specification.

B. Perform work in accordance with NFPA 70E and in compliance with OSHA requirements.

C. Do not perform work on exposed live electrical equipment.

1.7 **SUBMITTALS FOR REVIEW**

A. Submit according to the requirements of Division 01 and Section 27 0100.

B. Provide manufacturers installation instructions and product data for:

1. Fire-Resistant Joint Sealers.
2. Sleeves.

1.8 **SUBMITTALS FOR INFORMATION**

A. Submit according to requirements of Division 01 and Section - Structured Cabling General Requirements.

B. Submit written requests for System Interruptions and Outages as specified herein.

C. Submit Telecommunication Company prepared drawings two weeks prior to commencing Telecommunications service work.

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

1.9 **SUBMITTALS FOR CLOSEOUT**

A. Submit according to requirements of Division 01 and Section 27 0100.

B. Include product information and installation details with O & M manuals for fire resistant joint sealers and fire resistant sleeves.

PART 2 PRODUCTS

2.1 **HANGERS AND SUPPORTS**

A. Anchors and Fasteners:

1. Manufacturers
   a. RACO.
   b. Appelton
   c. Caddy
   d. B-Line
   e. Substitutions: Under provisions of Division 01 and Section - Structured Cabling General Requirements.

2. Concrete Structural Elements: Use precast insert system, expansion anchors, powder actuated anchors and preset inserts.
3. Steel Structural Elements: Use beam clamps, spring steel clips, steel ramset fasteners, and welded fasteners.
4. Concrete Surfaces: Use self-drilling anchors and expansion anchors.
5. Hollow Masonry and Gypsum Board Partitions: Use toggle bolts and hollow wall fasteners.
6. Solid Masonry Walls: Use expansion anchors and preset inserts.
7. Sheet Metal: Use sheet metal screws.
8. Wood Elements: Use wood screws.

B. Steel Channel:

1. Manufacturers:
   a. B-Line Systems, Inc.
   b. Unistrut ®.
   c. Substitutions: Under provisions of Division 01 and Section - Structured Cabling General Requirements.
2. Description:
   a. Hot dip galvanized where located outdoors and in wet/damp locations.
   b. Painted steel indoors in dry locations.
   c. Paint cut ends of channel in damp locations.
   d. Stainless steel or nonmetallic channel as shown on plans.

C. Powder Activated Anchors: Remington. Substitutions: Under provisions of Division 01 and Section - Structured Cabling General Requirements.

D. Spring Steel Clips:

1. Caddy
2. Steel City
3. Substitutions: Under provisions of Division 01 and Section - Structured Cabling General Requirements

E. Miscellaneous Metals:

1. Steel plates, shapes, bars, and bar grating: ASTM A 36.
2. Cold-Formed Steel Tubing: ASTM A 500.
3. Hot-Rolled Steel Tubing: ASTM A 501.
4. Steel Pipe: ASTM A 53, Schedule 40, welded.
5. Nonshrink, Nonmetallic Grout: Premixed, factory-packed, nonstaining, noncorrosive, nongaseous grout, recommended for interior and exterior applications.
6. Fasteners: Zinc-coated, type, grade, and class as required.

F. Miscellaneous Lumber:

1. 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 that 19 percent.
2. Construction Panels: Plywood backboards; APA A-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 3/4 inches.

2.2 JOINT SEALERS

A. General: Joint sealers, joint fill material, and other related materials compatible with each other and with joint substrates under conditions of service and application.

B. Colors: As selected by the Project engineer from manufacturer's standard colors.

C. Provide fire resistant joint sealers as specified in Division 07.

D. Fire-Resistant Joint Sealers: One-part or two-part, foamed-in-place, sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes, ducts and through penetrations through fire-rated walls, ceilings, roofs and floors. Sealants and accessories shall have required fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

2.3 SLEEVES

A. Sleeves for Raceways and Cables

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized Steel.
2. Rectangular Sleeves: Galvanized Sheet Steel. 16 Gauge for less than 50 square inches and not side longer than 16 inches. 8 gauge for greater than 16 inches or one side more than 16 inches.

B. Sleeve Seals

1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
2. 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. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.
   e. Link Seal.
3. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
4. Pressure Plates: Carbon steel. Include two for each sealing element.
5. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element
6. Provide fire rated seals as required. See Division 07.

2.4 CONCRETE

A. Concrete shall conform to Division 03 of this specification.

PART 3 EXECUTION

3.1 COMMON REQUIREMENTS FOR EXAMINATION PRIOR TO STRUCTURED CABLING INSTALLATIONS

A. Verify conditions and constructions types prior to installation.

B. Verify that surfaces that support Product(s) are ready to receive them.

C. Examine location of equipment installation for compliance with installation tolerances and other conditions affecting performance of Work

1. Prepare drawings showing proposed rearrangement of work to meet Project conditions, including changes to work specified in other Divisions. Obtain permission of Architect before proceeding.

D. Review all Drawings including architectural, mechanical, structural, civil, and electrical drawings for extent of Work.

1. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.

E. Examine Architectural drawings and elevations to verify device locations and mounting heights.
   1. In finished spaces, where mounting heights are not detailed or dimensioned coordinate mounting height with Architect.
   2. Do not rough-in for any wall mounted equipment without verifying mounting height with Architect unless equipment is specifically noted on Architectural Drawings.
   3. Do not scale dimensions from Electrical Drawings and verify all mounting heights noted on Electrical Drawings.

F. Site Investigation
   1. Prior to beginning work, examine the work site to become familiar with existing conditions which may affect the cost of the project. This includes measurements for lengths, quantities, clearances and all other field verifiable conditions.
   2. No extra charges will be allowed because of failure of Contractor to become familiar with all existing conditions prior to beginning work.
   3. Existing equipment, systems and installations whether or not they are not detailed on the drawings must be restored to their original condition.

3.2 COMMON REQUIREMENTS FOR PREPARATION TO INSTALLATION

A. Equipment Wiring preparation
   1. Obtain and review shop drawings, product catalog data, etc. prior to roughing-in for structured cabling connections.
   2. Verify dimensions and final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
   3. Refer to equipment drawings and specifications in all specification Divisions for rough-in requirements.

B. Telecommunications Service Entrance preparation
   1. Coordinate location of Telecommunication Company's facilities to ensure proper access is available.
   2. Verify that field measurements are as indicated on Telecommunication Company drawings.
   3. Pre-Installation meeting: Convene two weeks prior to commencing work of this section with Telecommunication Company representative, General Contractor, and other trades affected by site work to coordinate final location underground telecommunication Work.

C. Demolition and remodeling preparation.
   1. Notify the Owner and Architect at least five (5) days prior to commencing demolition operations
   2. Demolition Drawings are based on field observation and existing record documents. Report discrepancies to Architect before disturbing existing installation.
   3. Verify existing structured cabling arrangements and control apparatus and wiring.
   4. Verify that abandoned wiring and equipment serve only abandoned facilities.
   5. Review existing equipment and materials with the Owner, schedule or indicate equipment to be salvaged for re-use and equipment to be salvaged and turned over to the Owner.
   6. Beginning of demolition means Contractor accepts existing conditions.
   7. Extension of existing structured cabling and or systems: Prior to connecting any new Work to existing systems Contractor shall provide field measurements and surveys required to ensure adequate capacity is available for new connections.

D. Hangers and Supports preparation
   1. Coordinate the installation of required supporting devices, inserts and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed. Strength of construction shall not be impaired.
   2. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for structured cabling installations. Strength of construction shall not be impaired.

3.3 COMMON INSTALLATION REQUIRMENTS FOR STRUCTURED CABLING WORK

A. Description Of Wiring Methods:
   1. All wiring shall be installed in accordance with applicable codes and as noted in Section 270000, unless otherwise indicated.

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

C. Install work in locations shown on drawings, unless prevented by Project conditions. Refer to architectural drawings for exact devices locations.

D. Conform to arrangements indicated by Contract Documents, recognizing that the Work is shown only in diagrammatic form.

E. Install systems, materials and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

F. Install materials and equipment giving right-of-way priority to systems required to be installed at a specified slope.

G. Core drilling of concrete is required, where possible, in lieu of hammer drilling. Hammer drilling is generally to be limited to small holes for anchors.

H. Install access door assembly where units are concealed behind finished surfaces. Access doors are specified in Division 08 and this section.

I. Hangers and Supports
   1. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
   2. Do not fasten supports to pipes, ducts, mechanical equipment and conduit. Do not drill or cut structural members.
   3. Fabricate supports from structural steel or formed steel members. Rigidly weld members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

J. Floor, Wall And Ceiling Penetrations
   1. Effectively seal penetrations in exterior walls, roofs, and rated interior walls in accordance with Division 07.
   2. Examine substrates, areas, and conditions, for compliance with requirements for installation tolerances and other conditions affecting installation and application of joint sealers and access door units. Do not proceed with installation until unsatisfactory conditions have been corrected.
   3. Conduits and cables passing through floors, walls, and ceilings at the following locations shall be sealed for the purpose of sound, heat, smoke and / or moisture control.
      a. Acoustically rated walls.
      b. Fire and / or smoke resistant walls and floors.
      c. All electrical rooms.
      d. All mechanical rooms.
      e. Penthouse.
      f. All exterior walls.
      g. All vertical and horizontal shafts.
      h. All walls around janitor rooms, receiving rooms, and other facility maintenance and management rooms.
      i. Food service areas.

4. Where conduits and raceways pass through interior walls and ceilings (not requiring water proofing) provide suitable sealing material complying with Division 07 for the wall construction; examples:
   a. Plaster for plaster walls.
   b. Joint compound for gypsum board walls.
   c. Mortar for masonry block and brick walls.
   d. Grout for concrete walls.
5. Place sealing material around each conduit and raceway for the full thickness of the wall.
6. Where conduits and raceways pass through exterior walls and ceilings below grade, provide installation to meet the details noted on the Drawings.
7. Where interior walls require waterproof conduit and raceway seals, provide silicone sealant generally installed as specified above for exterior walls.
8. Where conduits and raceways pass through exterior walls above grade, provide matching wall material inside (see examples above) and provide waterproof seal of silicone sealant or other approved sealant on outside.
9. At the nearest point of access to wires (inside conduit or raceway) passing through exterior walls and roof; provide "Ductseal" between wires and conduit or raceway as a wind barrier.
10. Where cables pass through walls, ceilings and floors, generally use same sealing method as for conduits.
11. "Ductseal" type material is generally not acceptable except as noted above.
12. Utilize fire rated cabling pathways where cabling must be routed through fire-rated floor and wall assemblies.

K. Roof Penetrations
   1. Structured Cabling Contractor shall be responsible for providing roof seals for each raceway, mast, tower leg, guy wire, etc., which pass through roof, rest on roof or attach to roof. Avoid roof penetrations where possible. This work shall be performed by the Roofing Contractor. Structured Cabling Contractor shall coordinate work as needed.

L. Cutting, Patching, and Finishing
   1. General: Perform cutting, patching and finishing in accordance with Division 01.
      a. Cut, remove, and legally dispose of material including but not limited to construction material, and other indicated material made obsolete by the new work.
      b. Protect the structure, furnishings, finishes, and adjacent materials and installations not indicated or scheduled to be cut or removed.
      c. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt into adjacent areas.
      d. The Contractor shall not endanger the stability of the structure by cutting, excavation or otherwise.
      e. Do not cut or alter work of any other trade without trade and Architect / Engineer's consent.
   2. Perform cutting, patching and finishing of walls, floors, ceilings, roofs required to:
      a. Uncover work to provide for installation of new or ill-timed work.
      b. Remove and replace defective work.
      c. Remove samples of installed work as specified for testing.

3. Upon written instructions from the Architect / Engineer, uncover and restore work to provide for Engineer's observation of concealed work.
4. Should any cutting be required for proper installation of structured cabling work because of failure to give the General Contractor the proper information at the time required, such cutting shall be done at the structured cabling Contractors expense.

M. Equipment wiring installation

1. Provide all necessary boxes, raceways, and wiring required to make equipment and systems complete and operable.
2. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings.
3. Install structured cabling equipment to facilitate servicing, maintenance, and repair or replacement of structured cabling components.
4. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
5. Make structured cabling connections in accordance with equipment manufacturer's instructions.
6. Make conduit connections to equipment using flexible metal conduit. Use liquidtight flexible metal conduit with watertight connectors in damp or wet locations.
7. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
8. Provide suitable structured cabling receptacle outlet to accommodate connection with attachments.
9. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

3.4 DEMOLITION AND REMODELING

A. General Demolition:

1. Remove, relocate, and extend existing installations to accommodate new construction.
2. Where indicated or required, remove existing structured cabling systems in walls, floors, and ceilings scheduled for removal.
3. Where abandoned wiring serves equipment and / or facilities not indicated to be removed Contractor shall extend and / or reroute wiring to maintain service to the equipment that shall remain.
4. Repair adjacent construction and finishes damaged during demolition and extension work.
5. Maintain access to existing structured cabling installations which remain active. Modify installation or provide access door unit as appropriate.

B. Raceway and Box Demolition:

1. Remove all abandoned conduit, unless indicated to remain for re-use or future work, including abandoned conduit exposed during demolition and located above accessible ceilings.
2. Cut concealed abandoned conduit flush with walls and floors that are indicated to remain.
3. Remove abandoned boxes if conduit servicing them is removed.
4. Provide appropriate blank cover for abandoned boxes which are not removed.

C. Conductor and Cabling Demolition:

1. Remove all abandoned conductors and cabling in their entirety.

D. Equipment Demolition:

1. Where indicated or required, remove all stems, brackets, hangers, supports, etc.
2. Remove, demount, and disconnect existing structured cabling materials and equipment indicated to be salvaged, and deliver same to the location designated for storage. Leave in good condition and store in orderly manner.
3. Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

E. Maintain existing systems in service until new systems are complete and ready for use.

1. Disable existing systems only to make switchovers and connections.
2. Notify Architect, Construction Manager, and Owner and obtain permission before partially or completely disabling systems.

3. Minimize outage duration and coordinate time with Owner at his convenience.
4. Make temporary connections to maintain service, when outage time exceeds 8 hours or more.

3.5 TELECOMMUNICATION SERVICE

A. Make arrangements with Telecommunication Company to obtain permanent telecomm service to the Project.

B. Coordinate location of Telecommunication Company's facilities to ensure proper access is available.

C. Verify that field measurements are as indicated on Telecommunication Company drawings.

D. Pre-Installation meeting: Convene two weeks prior to commencing work of this section with Telecommunication Company representative, General Contractor, and other trades affected by site work to coordinate final location of underground structured cabling Work.

E. In addition to his own investigations, the Contractor is encouraged to call the following marking services prior to digging for any underground work:

1. North Dakota - 1-800-795-0555 (Location alert)

3.6 INTERRUPTIONS AND OUTAGES

A. Coordinate telecommunication service outages and disconnections with telecommunication Company.

B. Provide temporary wiring, connections, and protection as required to maintain all existing systems to remain in service during construction.

C. Owner approval is required prior to telecommunication service outages or energizations and shall be scheduled at the convenience of the Owner.

1. A written request must be submitted to the Owner / Architect / Engineer for approval a minimum of 15 days prior to outage or energization.
2. Cancellation of the planned interruption by the Owner for any reason, at any time up to 24 hours before planned interruption shall bear no additional cost to the Owner.

D. Minimize outage time and provide manpower such that work can be carried out at multiple locations if required.

E. Outages may require the Contractor to work at other than regular normal working hours. No extra compensation will be allowed for such times.

3.7 EQUIPMENT AND DEVICE MOUNTING HEIGHTS

A. Coordinate final mounting heights as directed under Part 3 paragraph “Preparation”.

B. Interior mounting heights indicated on drawings are from finished floors (interior) or final grade (exterior). Mounting heights for items indicated on exterior walls are from the interior finished floor below.

C. Mounting heights indicated are to the top of the device plate unless noted otherwise. Mounting heights are nominal and shall be adjusted to fit block joints.

D. Typical mounting heights are detailed on the Drawings.

E. Contractor shall verify mounting heights of all outlets to assure installation above top of radiation covers, mirrors, counters, vanity, cabinets, and any other obstruction that may alter indicated mounting heights. ADA accessible controls must be mounted at 48”.

3.8 COMMON REQUIREMENTS FOR OWNER INSTRUCTION AND DEMONSTRATION

A. Furnish, without additional expense to the Owner, the services of competent instructors, who will give full instructions in the care, adjustment and operation of all parts of the communications equipment to the Owner's employees who are to have charge of the equipment. Including but not limited to the following:

1. Demonstrate the proper operation of systems per the operational and function requirements of the Contract Documents and as outlined in any sequence of operation.
2. Instruct personnel, in all phases of operation, location of components and use of all systems.
3. Review manufacturer Warranty information for all equipment included in the manual.

B. Number of hours of instruction shall be specified in other sections of this specification.

C. An operating and maintenance manual shall be made available to the Owner's operating personnel during the instruction and left with the Owner upon completion of the instruction.

D. Owner instruction / demonstration shall be provided as noted below and as noted in specification sections (see individual specification section for additional requirements):

1. Intercom System - See specification.
2. Sound System - See specification.

E. Documentation: Upon completion of Owner Instruction and Demonstration provide a certificate signed and dated by the attendees indicating information covered, amount of instruction / demonstration time provided, and applicable specification sections. Provide certificate for all Owner Instruction and Demonstration sessions. Include copy with O & M Manual. A sample certificate is attached for reference.

3.9 FIELD QUALITY CONTROL

A. So far as possible contractor shall keep same foreman and workmen throughout project duration. Keep enough workmen on job to insure keeping up with or ahead of other trades so that no delays occur.

B. Delivery, Storage, and Handling

1. Deliver, store, protect and handle products on site under provisions of Division 01 according to manufacturer’s recommendations and as specified herein.
2. This Contractor shall make provisions for delivery and safe storage of materials.
3. Accept Products on site. Inspect for damage
4. Protect Products from corrosion and entrance of debris. Provide appropriate covering. During construction, it shall be the responsibility of this Contractor to protect the surface of equipment and material furnished.
5. See individual specifications sections for specific delivery, storage, handling and protection requirements.

3.10 CLEAN-UP, KEY CONTROL, AND PAINTING

A. Remove all packing materials, rubbish, debris, etc. from the site each day.

B. String all furnished keys on split metal key ring and turn same over to Owner at project completion.

END OF SECTION

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SECTION 27 05 28 - PATHWAYS FOR COMMUNICATION SYSTEMS

PART 1 GENERAL

1.1 SECTION INLCUDES

A. Pathways include
   1. Cable Tray.
   2. Conduit and Backboxes.
   3. Hangers and Supports.
   4. Non-continuous Cable Supports.

B. Cabling pathway for the following:
   1. Voice and Data Cabling.
   2. Overhead Paging Cabling.

1.2 RELATED DOCUMENTS

A. Drawings, addenda and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification Sections, apply to this and all other sections of Division 26, 27, and 28.

B. See Section 26 0100 Electrical Systems Close Out Documentation.

C. See Section 26 0533 Raceway And Boxes For Electrical Systems.

1.3 REFERENCES

A. Provide Work and Products in accordance with the following standards:
   1. NFPA 70 National Electrical Code
   2. ANSI/ TIA/ EIA 569 Commercial Building Standard for Telecommunications Pathways and Spaces, current revision level.
   3. ANSI/ TIA/ EIA 568 Commercial Building Telecommunications Cabling Standard, current revision level.
   4. NEMA VE-2-2006 - Cable Tray Installation Guidelines

1.4 QUALITY ASSURANCE

A. Contractor shall obtain and review NEMA VE-2-2006.

1.5 SUBMITTALS FOR REVIEW

A. Submit according to the requirements of Division 1 and Section - Electrical General Requirements.

B. Provide submittal for each product specified.

C. In addition to the information noted in Section - Electrical General Requirements Submittal shall include the following information:
   1. Shop Drawings: Show fabrication and installation details, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings for the following:
      a. Each cable tray system.

      b. Each non-continuous cable support system.

1.6 SUBMITTALS FOR INFORMATION

A. Submit according to the requirements of Division 1 and Section - Electrical General Requirements.

B. Submit the following:

1.7 **SUBMITTALS FOR CLOSEOUT**

A. Submit according to the requirements of Division 1 and Section 26 0100.

B. Operation and Maintenance Manuals: Include copy of the approved and edited (i.e. documents have been edited to reflect review comments) submittals for review.

C. Record Drawings: Indicate actual route of and locations of cable tray, non-continuous cable support systems, and conduits 1-1/4" and larger. Indicate actual locations of outlets. Include description of installed grounding and bonding system, note locations of connections to grounding electrode system and / or building steel system.

PART 2 PRODUCTS

2.1 **HANGERS AND SUPPORTS**

A. As specified in section - Basic Electrical Materials and Methods.

2.2 **NON-CONTINUOUS CABLE SUPPORT SYSTEM**

A. Manufacturer: Erico CableCat or Equal.

B. Description:

1. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; UL Listed.
2. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
3. Non-continuous cable supports sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
4. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
5. Stainless Steel non-continuous cable supports are intended for indoor and outdoor use in non-corrosive environments or where only mildly corrosive conditions apply.
6. Non-continuous cable supports shall be ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64, CAT21SS, CAT32SS, CAT64SS; CAT-CMTM Double J-Hook CAT100CM; CAT-CMTM U-hook series CAT200CMLN, CAT300CMLN; and CAT-CMTM retainer CATRT200CM, CATRT300CM or approved equal.

C. Type: (Adjustable)

1. Constructed from steel and woven laminate; sling length can be adjusted to hold up to 425 4-pair UTP; rated for indoor use in non-corrosive environments. Rated to support Category 5 and higher cable, or optical fiber cable; UL Listed.
2. Adjustable non-continuous cable support sling shall have a static load limit of 100 lbs.
3. Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces.
4. Acceptable products: ERICO CADDY CableCat™ CAT425; or approved equal

D. Type: (Multi Tiered)

1. Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies may be factory assembled or assembled from pre-packaged kits. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports, rated for indoor use in non-corrosive environments; UL Listed.
2. If required, the multi-tier support bracket may be assembled to manufacturer recommended specialty fasteners including beam clamps, flange clips, C and Z purlin clips.
3. The multi-tiered support bracket shall consist of ERICO CADDY CATHBA and CableCat™ J-Hooks with screws; or approved equal.
4. If required, assemble to manufacturer recommended specialty fasteners including beam clips, flange clips, C and Z purlin clips.

E. Cable Tie Type: Equal to Panduit Extra-heavy cable tie mounts.

F. Cable Tie and Loop: Equal to Panduit Tak-Ty hook and loop cable tie mounts.

G. Accessories

1. Cable Pulley

a. Non-continuous cable supports may be used as an installation tool when a removable pulley assembly is included. The pulley shall be made of plastic and be without sharp edges. The pin and bail assembly must be able to be secured to the J-Hook during cable installation. The pulley must remain secured while cables are being pulled.

b. The pin and roller assembly must be removed after cables are installed.

c. Acceptable products: ERICO CADDY CAT32PLR, CAT64PLR, or approved equal.

2. Cable Protector
   a. The protective steel tube shall fit over threaded rod and be at least 4” in length.

   b. The tube shall prevent damage to cables placed in or pulled through CAT-CMTM U-hooks. The tube shall not inhibit the pulling of cables.

   c. Acceptable products: ERICO CAT-CMTM CATTBCM, or approved equal.

2.3 CONDUIT AND BACKBOXES

A. As specified in Section - Raceway and Boxes for Electrical Systems.

2.4 CABLE RUNWAY

A. Manufacturer:
   1. Hoffman
   2. Panduit
   3. Basor Electric
   4. MP Husky
   5. Substitutions: According to Division 01 and Section 26 0000.

B. Ladder rack / cable runway for use in telecommunication rooms and spaces.

C. UL listed for Equipment grounding (straight and curved sections).
   1. Classified as suitable for an equipment grounding conductor.
   2. Provide required grounding jumper kits.

D. Cross members 9” on center.

E. Butt splice kits and junction-splice kits. Provide as needed to install as indicated on drawings.

F. Black polyester powder coat.

G. Width: as indicated on Drawings.
   1. Provide two radius drop kits minimum per rack and at each point where runway meets wall.

H. Supports:
   1. Provide support racks as required to suspend runway from ceiling where span from wall to wall is longer than manufacturer’s maximum dimension between suports. Center support kits only.
   2. Provide triangle support racks to support runway from wall where runway is routed along wall.
   3. Pro wall angle support where runway terminates at a wall.

2.5 RAIL-TYPE CABLE TRAY

A. Manufacturers:
   1. Square D.
   2. B line
   3. Cablofil
   4. Chalfant
   5. Basor Electric
   6. MP Husky
   7. Substitutions under provisions of Division 01 and Section - Electrical General Requirements.

B. Description: NEMA VE 1, Class 20C ladder vented type tray.

C. Material: Steel or Aluminum.

D. Finish: ASTM A 525, mill-galvanized before fabrication or painted with epoxy of Architect color choice.

E. Inside Width: As indicated on drawings.

F. Inside Depth: As indicated on drawings.

G. Straight Section Rung Spacing: 6 inches on center.

H. Hangers: trapeze.

I. Fittings: Provide vertical and/or horizontal tees and/or bends with radius as required or as indicated on drawings. Match straight section tray type.

J. Provide manufacturer's standard clamps, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.

K. Covers: vented. Material and finish to match tray.

2.6 WIRE BASKET-TYPE CABLE TRAY

A. Manufacturers:

1. B line
2. Cablofil
3. Chalfant
4. Basor Electric
5. MP Husky
6. Substitutions under provisions of Division 01 and Section - Electrical General Requirements.

B. Description: NEMA VE 1, Class 20C wire basket type tray.

C. Material: Steel

D. Finish: Zinc coated.

E. Inside Width: As indicated on drawings.

F. Inside Depth: 4” unless noted otherwise.

G. Hangers:

1. Center hung.
2. Wall mounted.
3. Trapeze.

H. Fittings: Provide vertical and/or horizontal tees and/or bends with radius as required or as indicated on drawings. Match straight section tray type.

I. Provide manufacturer's standard clamps, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.

J. Covers: Solid, ASTM A 525, mill-galvanized before fabrication.

2.7 WARNING SIGNS

A. Engraved Nameplates: Black letters on yellow laminated plastic nameplate, engraved with the following wording:

1. WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES AND TUBING!

2.8 FIRE BARRIER CAULK

A. Manufacturer:

1. 3M Fire Barrier Caulk CP25.
2. Hilti.
3. Or equal.

2.9 **FIRESTOP (FIRE-RATED CABLE PENETRATION)**

A. Manufacturer: STI “EZ Path”
   1. Specified Technology Inc. - EZ Path.
   2. Hilti.
   3. Substitutions under provisions of Division 01 and Section - Electrical General Requirements.

B. Description:
   1. Automatically adjusts to cable fill via intumescent insert material allowing for 0 to 100-percent visual fill of conductors.
   2. Includes both internal and external fire stopping.
   3. Cables penetrating through fire-rated floors or walls shall utilize fire-rated pathway devices capable of providing an F rating equal to the rating of the barrier in which the device is installed.
   4. The device shall be tested for smoke leakage (L rating).
   5. Wire devices shall be of a sufficient size to accommodate the quantity and size of electrical wires and data cables required and shall be suitable for use with new or existing cable installations.

C. 1.5”, 3”, or 4” as required for project conditions or as noted on drawings.

2.10 **FIRESTOP (PILLOWS)**

A. Manufacturer:
   1. KBS “Sealbag”.
   2. Hilti.
   3. Or equal.

B. Description:
   1. Size as required for size of cable tray, quantity of conductors or as indicated on drawings whichever is larger.
   2. UL listed fire-rated assembly through fire-rated partitions, and walls.

PART 3 EXECUTION

3.1 **EXAMINATION**

A. Review location of installation to verify suitability of products installation. Verify environmental conditions are within manufacturer’s suggested tolerances.

3.2 **PREPARATION**

A. Pre-installation meeting: Convene one week prior to commencing work of this section with General Contractor, Mechanical Contractor and all affected trades to coordinate route, clearances, etc.

B. The contractor must coordinate the installation of the new pathways with other trades and project requirements. Revise locations and elevations from those indicated as required to suit field conditions and as approved by Owner representative,

C. The contractor shall reference the related sections listed above to determine any additional requirements necessary to complete the project.

D. Coordinate locations of required fire-rated construction with Architect.

3.3 **INSTALLATION**

A. General Requirements:
   1. The communications cabling pathways shall provide a route from the building’s communications rooms to the communication outlet and provide a neat and workmanlike installation. Cables shall be routed parallel to or at right angles to building lines.
   2. All products are to be installed per the manufacturer’s instructions and procedures.
   3. All pathways must remain accessible and useable after completion.

B. Conduit Requirements:

C. Back box requirements:

1. The communication system outlet box will be a 4”x4” square box fitted with a single gang mud ring unless noted otherwise.
2. Communication system outlets are not to be installed back to back.
3. Firestop the outlet box using a listed UL application in firewalls.

D. Non-Continuous Cable Support Requirements:

1. Install system Category compliant cable supports every 36” where cable tray is not used.
2. Install such that cabling is routed parallel to or at right angles to building lines.

E. Cable Tray System:

1. Cable tray will be installed where shown on drawings.
2. Cable tray system shall not be loaded beyond 60% of manufacturer’s recommended load capacity.
3. Support trays in accordance with manufacturer’s instructions. Provide supports at each connection point, at the end of each run, and at other points to maintain spacing between supports of 8 ft maximum.
4. Coordinate with other trades to provide for adequate clearances.
5. Bond cable tray to building’s grounding electrode system (preferably the building steel) at intervals no greater than 60’ using manufacturer approved methods and products (minimum #10 AWG insulated stranded copper conductor where the tray system is not bonded to the building steel through a metallic support system).
6. Provide continuity between tray components, bond together with a minimum of #10 AWG insulated stranded bonding jumper.
7. Wire mesh tray systems, provide #10 AWG insulated stranded copper conductor the entire length of the tray. Bond cable tray system at splices, fittings, and horizontal and vertical adjustments.
8. Install warning signs at 50 feet centers along cable tray, located to be visible.

F. Fire Rate Cabling Penetrations

1. Utilize UL listed removable/re-usable fire stopping assemblies where required.
2. Provide restorable fire stops inside and around conduits as recommended by UL1479 or ASTM E814 for all conduits penetrating fire-rated construction.

3.4 FIELD QUALITY CONTROL

A. Receive and unload cable tray in accordance with NEMA VE-2-2006 and the manufacturer’s requirements.

B. Store cable tray in accordance with NEMA VE-2-2006 and the manufacturer’s requirements.

3.5 DOCUMENTATION

A. Provide certificate(s) according to requirements of specification section - Operation and Maintenance of Electrical Systems indicating that system bonding and grounding has been installed (include description of installation), spare capacity has been provided and that the entire installation is in accordance with these specifications.

END OF SECTION

SECTION 27 08 13 - TESTING OF STRUCTURED CABLING SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section includes general requirements that pertain to all Performance Verification Testing and Acceptance Testing requirements listed in Division 27 specifications.

B. See Part 3 paragraph titled “Field Quality Control” of individual specification sections of Division 27 for test methods, procedures, test values, etc. specific to the materials and labor specified in that section.

C. This section includes required tests applicable to Division 27 work in general.

1.2 RELATED DOCUMENTS

A. Drawings, addenda and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification Sections, apply to this and all other sections of Division 27.

B. Division 27 Specification Sections:

1. 27 0000 Structured Cabling General Requirements
2. 27 0100 Structured Cabling Close Out Documents
3. 27 0528 Pathways for Comm Sys
4. 27 1000 Communication Structured Cabling Systems
5. 27 5113 Intercom Systems
6. 27 5123 Sound System

1.3 DEFINITIONS

A. See Section 27 0000 for definition of performance verification testing and acceptance testing.

1.4 REFERENCES AND STANDARDS

A. NFPA 70 - National Electrical Code.

B. Occupational Safety and Health Act (OSHA).

C. ANSI/NFPA 70E, Standard for Electrical Safety in the Workplace.

D. ANSI/TIA/EIA-568-B.1: Part 1: General Requirements. This standard covers the general requirements for planning, installing, and verifying structured cabling systems in commercial buildings. It also establishes performance parameters for cable channels and permanent link. One of the major changes in this document from the earlier version is that it recognizes CAT5e or higher cabling for the second data outlet.

E. ANSI/TIA/EIA-568-B.2: Part 2: Balanced Twisted-Pair Cabling Components. This standard discusses balanced twisted-pair cabling components and transmission requirements.

F. ANSI/TIA/EIA-568-B.2-1: Part 2, Addendum 1: 4-Pair, 100-Ohm Category 6 Transmission Performance. This standard specifies components and transmission requirements.

G. ANSI/TIA/EIA-568-B.2-10 (Draft): Augmented Category 6 Transmission Performance.

H. EIA/TIA TSB-155: Characterizing Existing Category 6 Cabling to Support 10-Gigabit Ethernet.

I. ANSI/TIA/EIA-568-B.3: Optical Fiber Cabling Components Standard.

J. ANSI/TIA/EIA-568-B.3-1: Additional Transmission Performance Specifications for 50/125 Optical Fiber Cabling Systems.

K. ANSI/TIA/EIA-569-B: Commercial Building Standard for Pathways and Spaces.

L. ANSI/TIA/EIA-570-A: Residential Telecommunications Cabling Standard.

M. ANSI/TIA/EIA-606-A: Administration Standard for Telecommunications Infrastructure of Commercial Buildings.

N. ANSI/TIA-607: Commercial Building Grounding and Bonding Requirements for Telecommunications.

O. ANSI/TIA/EIA-758: Customer Owned Outside Plant.

P. ANSI/TIA/EIA-862: Building Automation Systems Standard for Commercial Buildings.

Q. ANSI/TIA/EIA-942: Telecommunications Infrastructure Standard for Data Centers

R. EIA/TIA TSB-36: Technical Systems Bulletin Additional Cable Specifications for Unshielded Twisted Pair Cabling.

S. EIA/TIA TSB-40A: Additional Transmission Specifications for Unshielded Twisted Pair Cabling.

T. EIA/TIA TSB-67: Transmission Performance Specifications for field testing of Unshielded Twisted Pair Cabling.

U. EIA/TIA TSB-72: Centralized Optical Fiber Cabling guidelines.

V. EIA/TIA-455-57A - Optical Fiber End Preparation and Examination

W. EIA/TIA 455-59 - Measurement of Fiber Point Defects Using An OTDR

X. EIA/TIA 455-60 - Measurement of Fiber or Cable Length Using An OTDR

Y. EIA/TIA 455-61 - Measurement of Fiber or Cable Attenuation Using An OTDR

Z. EIA/TIA 455-95 - Absolute Optical Power Test for Optical Fibers and Cables

AA. EIA/TIA 526-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant

BB. ANSI/ICEA S-83-596-1994 - Fiber Optic Premises Distribution Cable

CC. EIA/TIA TSB-1005: Telecommunications Infrastructure Standard for Industrial Premises

DD. EIA/TIA TSB-162: Telecommunications Cabling Guidelines for Wireless Access Points.

EE. ISO 11801:2002: Information Technology-Generic Cabling for Customer Premises.

FF. ISO/IEC 11801, 2nd Ed.: Includes Class D, E, and F Cabling.

GG. ISO/IEC 11801, 2nd Ed. Amendment 1: Covers Class EA and FA.* ISO 11801 Class Ea, Edition 2.1: 10-Gigabit over Copper.

HH. ISO/IEC TR 24704: Information Technology-Customer Premises Cabling for Wireless Access Points.

II. IEEE 802.3af: Power over Ethernet. (PoE).

JJ. IEEE 802.3at: Power over Ethernet Plus (PoE Plus)

KK. IEEE 802.11: Wireless Networking.

LL. IEEE 802.3an: 10GBASE-T 10 Gbps (1250 Mbps) Ethernet over Unshielded Twisted Pair (UTP).

MM. Occupational Safety and Health Act of 1970 State and Local Building, Electrical, and Safety Codes and Ordinances

NN. Owner's Safety Practices.

1.5 QUALITY ASSURANCE

A. Provide all testing listed for copper structured cabling:

1. Verification that all Horizontal Structured cabling does not exceed 90 meters.
2. Verification that all work area patch cabling does not exceed 5 meters.
3. Verification that all total structured cabling runs do not exceed 100 meters.
4. Verification that equipment patch, and work area cabling does not exceed 10 meters per run.
5. Wire Map
6. Insertion Loss
7. Return Loss
8. DC Loop Resistance
9. Propagation Delay
10. Delay Skew
11. Near-end crosstalk (NEXT)
12. Power-sum near-end crosstalk (PS-NEXT)
13. Equal-level far-end crosstalk (EL-FEXT)
14. Alien crosstalk (AXT)
15. Power-sum equal-level far-end crosstalk (PS-ELFEXT)
16. Attenuation to crosstalk ratio, far-end (ACRF)
17. Power sum attenuation to crosstalk ration, far end (PSACR-F)

18. Verification that testing meets or exceeds
    a. TIA-568-B.2 for Cat5e
    b. TIA-568-B.2-1 for Cat6
    c. TIA-568-B.2-10 for Cat6a
    d. ISO/IEC 11190 for Cat7

B. Provide all testing listed for optical structured cabling:
1. Verification that all Horizontal Optical Structured Cabling does not exceed manufacturer specified length
2. Verification that all Optical Cabling Bends/Turns do not exceed manufacturer specifications
3. Attenuation
4. Wire Map
5. Insertion Loss
6. Return Loss
7. Verification that testing meets or exceeds
    a. TIA-568-B.3-1

C. Testing Personnel: Technicians performing these tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated. These individuals shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. They must evaluate the test data and make a judgment on the serviceability of the specific equipment.

1.6 SAFETY AND PRECAUTIONS

A. Follow all safety regulations described in the standards listed above.

1.7 SUBMITTALS FOR REVIEW

A. Submit according to the requirements of Division 01
B. Follow all requirements of Division 27 0000

1.8 SUBMITTALS FOR INFORMATION

A. Submit according to the requirements of Division 01
B. Prior to substantial completion, provide written verifications of test results of various systems as required by inspecting authorities and by other sections of these specifications.
C. Provide written verifications that tests have been performed and provide test results.

1.9 SUBMITTALS FOR CLOSEOUT

A. Submit according to the requirements of Division 01 and Section 27 0100.
B. Operation and Maintenance Manuals: All test reports and / or certificates shall be included with the O & M Manuals.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

A. Provide all specialized tools, test equipment and instruments required to execute testing of equipment.
B. All specialized tools, test equipment and instruments shall be of sufficient quality and accuracy to test and/or measure system performance within specified tolerances.
C. Calibration:
1. A testing laboratory must have calibrated test equipment within the previous twelve (12) months.

2. Contractor must calibrate test equipment and instruments according to manufacturer's recommended intervals and whenever the test equipment is dropped or damaged. Calibration tags must be affixed to the test equipment or certificates readily available.
3. Calibrating standard shall be of better accuracy than that of the instrument tested.

2.2 **TEST REPORT**

A. The test report shall include the following:
   1. Summary of project.
   2. Description of equipment tested including a description of the equipment's location.
   3. Description of tests.
   4. Test data.
   5. Analysis and recommendations.
   6. Description of modifications made to improve test results.

B. Test Data shall include the following:
   1. Identification of the testing organization.
   2. Equipment identification.
   3. Humidity, temperature, and other conditions that may affect the results of the tests and/or calibrations.
   4. Date of inspections, tests, maintenance, and/or calibrations.
   5. Identification of the testing technician.
   6. Indication of inspections, tests, maintenance, and/or calibrations to be performed and recorded.
   7. Indication of expected results when calibrations are to be performed.
   8. Indication of as-found and as-left results, as applicable.
   9. Sufficient spaces to allow all results and comments to be indicated.

PART 3 EXECUTION

3.1 **PREPARATION**

A. Verify that field conditions are acceptable and are ready for testing.

B. Verify a suitable and stable source of electrical power is available at test site.

C. Verify that all equipment is installed and ready for testing.

D. Do not test or operate equipment for any purpose until it has been fully installed and serviced in accordance with the manufacturer's instructions.

E. Notify the Architect of equipment which is disclosed by test as unsatisfactory and replace equipment or wiring furnished under the Contract which is disclosed by tests as unsatisfactory.

3.2 **GENERAL PROCEDURES**

A. The contractor will provide all tools, equipment, and full trained staff necessary to conduct fully witnessed acceptance testing of all telecommunications- related products and systems.

B. The Contractor shall prepare a complete test plan for all installed building telecommunications systems for review and approval by the Engineer, Architect, and Owner. The plan will show, at a minimum, test configurations, calibrations procedures, impedances, and measurement equipment. The scope of this includes, but is not limited to, the following:
   1. All systems shall be checked for compliance with these specifications.
   2. The contractor shall maintain a check-off list for Engineer, Architect, and Owner reference during these tests.
   3. The result of the measurements outlined in this specification shall be recorded and submitted with current as-built drawings to the Engineer, Architect, and Owner as final proof of system performance.
   4. The contractor shall expeditiously replace any system not meeting specifications at no additional cost to the Engineer, Architect, or Owner. Failure to act in a expeditions manner to properly remedy any abnormality directly resulting from installation/construction defects or workmanship, faulty material, and/or failure of the systems, components, or the cable medium to perform in

accordance with the Engineer/Architect Specifications may cause a “file to stop work notice” on any other telecommunications development or construction associated with this project. The Engineer/Architect will notify the contractor in writing of such action and is absolved and shall be held harmless from any delays, cost over-runs, scheduling difficulties, etc. assessed by others due to the contractors failure to meet the final proof of system performance specifications. Final as-builts will be provided, as specified, at the end of the project.

5. All systems shall meet the bid specifications and be accepted by the Engineer before work will be considered complete.
6. After the Contractor has provided complete documentation of all testing and the documentation has been reviewed by the Engineer/Architect/Owner, the contractor shall conduct a “proof of performance” test on selected components at the direction and discretion of the Engineer/Architect/Owner. Such testing will utilize the same equipment and procedures used to conduct and document the initial testing, but will be applied on a random basis to verify the testing documentation. If in the judgement of the Engineer/Architect/Owner, the proof-of-performance test results vary significantly from the acceptance test results, the contractor shall continue testing until cleared by the Engineer/Architect/Owner.
7. All Testing shall be coordinated with the Engineer/Architect/Owner (providing a minimum two-week’s notice) to ensure all acceptance and proof-of-performance testing can be witnessed by qualified personnel.

3.3 EXECUTION

A. Perform tests noted herein and specified elsewhere in Division 27 specifications and as noted below.

B. Inspection and testing procedures for copper cabling.

1. The Engineer/Inspector will conduct routine inspections of the work in progress, and any deficiencies will be discussed at the regular progress meeting. In the event the Engineer/Inspector determines work is progressing in an incorrect manner and waiting for the regular meeting could cause further problems, the Contractor’s onsite project manager will be notified.
2. Copper Station Cables: The Contractor shall conduct witnessed acceptance testing on all station cables installed as part of this project as defined below:
    a. Each station cable and all riser cable pairs will be tested for crosses, opens, grounds, reversed and/or transposed pairs, shorts, foreign battery, continuity, and resistance (in ohms). All riser cable pairs shall be tested for loss in dB. All problems will be resolved and the cable re-tested to ensure compliance.

    b. Using a Category 6 rated pair scanner or similar device, all copper station cables will be tested to verify the installation meets the EIA/TIA Category 6 performance specifications as defined in TSB-40A and TSB 67. All test documentation shall be provided as individual prints of forms from data stored in the test instrument. The identification of each circuit shall be entered during the test and shall be part of the printed form. The form shall provide measured values for all parameters required per TSB-40A and TSB 67-A-5 with pass/fail indication for Category 6 requirements. The circuit identification on the test form shall be the same as that on the jack. All test results, including jack numbers, shall be printed on a hardcopy report. All copper station wires shall meet or exceed this performance standard.

    c. All pair scanners used on the project shall be calibrated to a single common test cable at the start of each shift and after changing batteries. The hardcopy of the calibration results shall be included as a reference with each batch of station test results submitted.

    d. Station wire test results shall also be provided in electronic format.

3. Copper horizontal cabling and Entrance Cables: The Contractor’s witnessed acceptance testing on all horizontal cabling and entrance cabling installed as part of this project as defined below

a. The correct and continuous bonding of cable shields through all outside plant cable splices shall be verified. This test shall be conducted from the MDF and BDF prior to strapping shield grounds at splice or termination points.

b. Each cable pair shall be tested for crosses, opens, grounds, reversed and/or transposed pairs, shorts, foreign battery, continuity, resistance (in ohms) and loss in dB.

c. All irregularities will be resolved and the cable re-tested to ensure compliance.

d. Copper horizontal cabling and Entrance Cable test results shall be provided in electronic format.

C. Inspection and testing procedures for Fiber cabling.

1. Fiber Optic Station Cable

a. The appropriate high resolution OTDR device shall be used to test the fiber station cable. Tracing printouts (noting the appropriate optical fiber and buffer tube color designation) shall be mounted on separate pages and bound into a three-ring notebook. An incremental scale that reflects the short lengths of cable involved in these tests shall be utilized.

b. All fiber station cable shall be tested from the building's BDF to each fiber station outlet. The results of OTDR testing to define the length of each station cable shall be documented. The Contractor shall conduct a power meter (loss) test of each fiber optic station cable at both wavelengths A to B, B to A, and OSPL (OSPL is defined as La + Lb). No individual station link segment (including connectors) shall measure more than 2.0 dB loss. Tests shall be conducted using ANSI/EIA/TIA-526-14A, Method B. The Contractor shall provide a typed list reflecting cable ID and actual measured loss.

c. Fiber optic station cable test results shall be provided in electronic format.

2. Fiber Optic Horizontal Cabling and Entrance cable.

a. The appropriate high resolution OTDR device to test the fiber horizontal cabling and entrance cables shall be used. Tracing printouts (noting the appropriate optical fiber and buffer tube color designation) shall be mounted on separate pages and bound into a three-ring notebook. An incremental scale that reflects the short lengths of cable involved in these tests shall be utilized.

b. All horizontal fiber optic cables shall be tested from the MDF to each building's BDF terminal. The results of OTDR testing to define the length of each inter-building cables shall be documented.

c. The Contractor shall conduct a power meter (loss) test of each fiber optic station and riser cable at both wavelengths A to B, B to A, and OSPL (OSPL is defined as La + Lb). No individual fiber link segment (including connectors) shall measure more than 2.0 dB. The tests shall be conducted using ANSI/EIA/TIA-526-14A, Method B. A typed list reflecting cable ID and actual measured loss shall be submitted to the Engineer of Record.

d. Fiber optic inter-building and entrance cable test results shall be provided in electronic format.

3.4 **DOCUMENTATION**

A. Provide written certificate(s) and include a copy with the O&M manuals, indicating that the inspections and tests specified herein have been performed.

B. Provide test reports as specified above in Part 2, and Part 3.

END OF SECTION

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SECTION 27 10 00 - STRUCTURED CABLING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Communications system design requirements.
B. Communications pathways.
C. Copper cable and terminations.
D. Fiber optic cable and interconnecting devices.
E. Communications equipment room fittings.
F. Communications outlets.
G. Communications grounding and bonding.
H. Communications identification.

1.2 REFERENCE STANDARDS

A. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment; Electronic Industries Alliance/Electrical Components Association; Revision E, 2005.
B. ICEA S-83-596 - Indoor Optical Fiber Cables; 2016.
C. NECA/BICSI 568 - Standard for Installing Building Telecommunications Cabling; National Electrical Contractors Association; 2006.
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
E. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; Rev A, 1988 (R2012).
F. TIA-526-14 - Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant; Rev C, 2015.
G. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2016.
H. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; 2009c, with Addendum (2016).
I. TIA-568.3 - Optical Fiber Cabling and Components Standard; 2016d.
J. TIA-569 - Telecommunications Pathways and Spaces; 2015d, with Addendum (2016).
K. TIA-598 - Optical Fiber Cable Color Coding; 2014d.
L. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2017c.
M. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2015c, with Addendum (2017).
N. UL 444 - Communications Cables; Current Edition, Including All Revisions.
O. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.
P. UL 1651 - Fiber Optic Cable; Current Edition, Including All Revisions.
Q. UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.
   2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
   3. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.

4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.4 SUBMITTALS

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

B. Field Test Reports.

1.5 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Contractor shall provide a 1 year parts and labor warranty against defective workmanship and/or system component failure.

1.6 Delivery Storage and Handling

A. Contractor shall ensure that materials delivery to work area shall be coordinated with construction site manager responsible for materials distribution to all trades.

B. Contractor is responsible for all materials, tools and vehicles left on the job site.

C. Contractor shall ensure materials are stored in an environmental area where:

1. Temperature does not exceed 120 degrees Fahrenheit nor below 32 degrees Fahrenheit.
2. Humidity does not exceed 80 %.
3. No direct exposure to sunlight.

D. Cable shall be stored according to Manufacturer’s recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees F., the cable shall be moved to a heated (50 degrees F. minimum) location. If necessary, cable will be stored off site at the Contractor's expense.

E. Store in a clean, dry space. Maintain factory protection or cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation. Meet the requirements and recommendations of NFPA 70B and the Manufacturer. Location will be protected to prevent moisture from entering enclosures and material.

F. Handle in accordance with NEMA and the Manufacturer’s recommendations and instructions to avoid damaging equipment, installed devices and finish.

G. The equipment will be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the Manufacturer will be required to brace the equipment suitably to insure that the tilting does not impair the functional integrity of the equipment.

PART 2 PRODUCTS

2.1 SYSTEM DESIGN

A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.

1. Comply with TIA-568 (SET) (cabling) and TIA-569 (pathways) (commercial standards).
2. Comply with Communications Service Provider requirements.
3. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
4. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
5. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.

B. In areas where the ceilings are being removed and replaced or reinstalled, communication devices in or on the ceilings are to be removed and reinstalled when the new ceilings are installed. Disconnect all ceiling mounted communication devices, clean, store and reconnect and reinstall.

C. In areas where the ceilings are being removed and replaced or reinstalled, properly support all existing communication cables that are laying on the ceiling system.

D. System Description:

1. Backbones - Within Building: Fiber optic, _____ -fiber.
2. Horizontal Cabling: Copper.

E. Main Distribution Frame (MDF): Centrally located support structure for terminating horizontal cables that extend to telecommunications outlets, functioning as point of presence to external service provider.

1. Locate main distribution frame as indicated on the drawings.

F. Backbone Cabling: Cabling, pathways, and terminal hardware connecting intermediate distribution frames (IDF's) with main distribution frame (MDF), wired in star topology with main distribution frame at center hub of star.

G. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.2 PATHWAYS

A. Conduit: As specified in Section 26 05 33.13; provide pull cords in all conduit.

2.3 COPPER CABLE AND TERMINATIONS

A. Copper Horizontal Cable:

1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2 and listed and labeled as complying with UL 444.
2. Cable Type - Voice and Data: TIA-568.2 Category 6 UTP (unshielded twisted pair); 23 AWG.
3. Cable Capacity: 4-pair.
4. Cable Applications: Use listed NFPA 70 Type CMP plenum cable unless otherwise indicated.

B. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.

C. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.

1. Performance: 500 mating cycles.
2. Voice and Data Jacks: 8-position modular jack, color-coded for both T568A and T568B wiring configurations.

2.4 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

A. Fiber Optic Backbone Cable:

1. Description: Tight buffered, non-conductive fiber optic cable complying with TIA-568.3, TIA-598, ICEA S-83-596 and listed as complying with UL 444 and UL 1651.
2. Cable Type: Multimode, laser-optimized 50/125 um (OM3) complying with TIA-492AAAC-B.
3. Cable Capacity: Quantity of fibers as indicated on drawings.
4. Cable Applications:
5. Cable Jacket Color:
   a. Laser-Optimized Multimode Fiber (OM3/OM4): Aqua.

B. Fiber Optic Interconnecting Devices:

1. Connector Type: Type LC.
2. Connector Performance: 500 mating cycles, when tested in accordance with TIA-455-21.
3. Maximum Attenuation/Insertion Loss: 0.3 dB.

2.5 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

A. Copper Cross-Connection Equipment:
   1. Manufacturers:
      a. CommScope; _____: www.commscope.com/#sle.

B. Equipment Frames, Racks and Cabinets:
   1. Manufacturers:
      a. CommScope; _____: www.commscope.com/#sle.

      b. Siemon Company; _____: www.siemon.com/#sle.

   2. Component Racks: EIA/ECA-310 standard 19 inch wide.
   3. Wall Mounted Racks: Steel construction, hinged to allow access to back of installed components.
   4. Floor Mounted Racks: Aluminum or steel construction with corrosion resistant finish; vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug.

C. Cable Management:
   1. Manufacturers:
      a. Siemon Company; _____: www.siemon.com/#sle.

      b. Substitutions: See Section 01 60 00 - Product Requirements.

2.6 COMMUNICATIONS OUTLETS

A. Manufacturers:
   1. CommScope; _____: www.commscope.com/#sle.
   2. Siemon Company; _____: www.siemon.com/#sle.
   3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Outlet Boxes: Comply with Section 26 05 33.16.
   1. Provide depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.

C. Wall Plates:
   1. Comply with system design standards and UL 514C.
   2. Accepts modular jacks/inserts.
   3. Capacity:
      a. Data or Combination Voice/Data Outlets: 2 ports.

   4. Wall Plate Material/Finish - Flush-Mounted Outlets: Match wiring device and wall plate finishes specified in Section 26 27 26.

2.7 GROUNDING AND BONDING COMPONENTS

A. Comply with TIA-607.

2.8 IDENTIFICATION PRODUCTS

A. Comply with TIA-606.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

A. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569 (pathways), TIA-607 (grounding and bonding), BICSI N1, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

B. Comply with Communication Service Provider requirements.

C. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.

D. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

E. Verify the exact location prior to bid of all items that may be indicated and determine exact location of all electrical items that are not indicated on the Drawings.

F. Refer to all Drawings associated with the project, prior to the installation or roughing-in of the electrical outlets, conduit and equipment, to determine the exact location of all outlets

G. Verify that interior of building has been protected from weather.

H. Verify that mechanical work likely to damage wire and cable has been completed.

I. Verify that raceway installation is complete and supported.

3.2 INSTALLATION OF PATHWAYS

A. Install pathways with the following minimum clearances:

1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
2. 12 inches from power conduits and cables and panelboards.
3. 5 inches from fluorescent and high frequency lighting fixtures.
4. 6 inches from flues, hot water pipes, and steam pipes.

B. Conduit, in Addition to Requirements of Section 26 05 33.13:

C. Outlet Boxes:

1. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of telecommunications outlets provided under this section.

3.3 INSTALLATION OF EQUIPMENT AND CABLING

A. Cabling:

1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
2. Do not over-cinch or crush cables.
3. Do not exceed manufacturer's recommended cable pull tension.
4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.

B. All cable and associated hardware shall be placed so as to make efficient use of available space in coordination with other uses. All cable and associated hardware shall be placed so as to not impair the use or capacity of other building systems, equipment, or hardware placed by others (or existing).

C. Cable Supports

1. Tie wraps for horizontal cables will be secured with minimum required compression in order to secure the cables properly without impeding the signal transmission rating (geometry) of the cable. Hook and loop (Velcro) cable wraps may be used in lieu of cable ties for copper cables only.

D. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:

1. At Distribution Frames: 120 inches.
2. At Outlets - Copper: 12 inches.
3. At Outlets - Optical Fiber: 39 inches.

E. Copper Cabling:

1. Category 5e and Above: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
3. Use T568B wiring configuration.

F. Fiber Optic Cabling:

1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
2. Support vertical cable at intervals as recommended by manufacturer.

G. Wall-Mounted Racks and Enclosures:
   1. Install to plywood backboards only, unless otherwise indicated.
   2. Mount so height of topmost panel does not exceed 78 inches above floor.

H. Floor-Mounted Racks and Enclosures: Permanently anchor to floor in accordance with manufacturer's recommendations.

I. Identification:
   1. Use wire and cable markers to identify cables at each end.
   2. Use manufacturer-furnished label inserts, identification labels, or engraved wallplate to identify each jack at communications outlets with unique identifier.
   3. Use identification nameplate to identify cross-connection equipment, equipment racks, and cabinets.
   4. All communications equipment racks, cabinets, backboards and other termination hardware shall be labeled at the top left hand corner of each piece of equipment. With a minimum ¾" high identification label, identifying the room and rack location numbering system.
   5. All communication copper and fiber patch panels shall be labeled with a minimum 3/8" high identification label identifying panels and sequential port numbering system.
   6. All face plates locations shall be labeled with a minimum 3/16" high label indicating the room rack, patch panel and port number.
   7. No hand written labeling will be allowed.
   8. The chosen alphanumeric labeling system shall be approved by Owner prior to any permit labeling system shall be installed.
   9. IDC style connecting hardware shall be color coded per the code identified the BICSI TDMM.

J. Separation from EMI sources:
   1. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment will be as follows
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
   2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment will be as follows
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
   3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures will be as follows
      a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
   4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
   5. Separation between Communications Cables and Fluorescent or LED Fixtures: A minimum of 5 inches.

K. Cable Protection
   1. Provide bushings in all metal studs and the like where cables will pass through. Bushings will be of two (2)-piece construction with one piece inserted through the opening and the second piece

locking it into place. Single piece bushings with locking tabs or friction fit are specifically prohibited.

2. Cables to be installed in existing enclosed open bays or furred spaces where conduit stubs are not provided, will be protected from chafing or any damage. The Installer will verify that the warranty will not be violated before installing any cabling in these locations.
3. Provide cutting, coring, sleeves and bushings and seal as required at all penetrations.
4. Cables damaged during installation will not be repaired. They will be completely replaced with new cable at no cost to the Owner.

3.4 Preparation

A. Equipment and systems will not be installed without first coordinating the location and installation of equipment and systems with the General Contractor and all other Trades.

B. Any and all material installed or work performed in violation of above requirements will be re-adjusted and corrected by the Installer without charge

C. Obtain and review detailed information on installation requirements from the Manufacturers of all equipment to be furnished, installed or provided. At the start of construction, check all Contract Documents include all Drawings and all Sections of the specifications for equipment requiring electrical connections and service and verify electrical characteristics of equipment prior to roughing in.

D. Completely and thoroughly swab raceway before installing wire.

E. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and housing when so directed by service provider.

F. Coordinate layout and installation of communication equipment.

G. The contractor shall not be responsible for making the cross connect between the indoor cable termination and the OSP cable field, unless otherwise instructed.

H. Contractor shall coordinate all cable pathways on site with other trades before construction.

3.5 Firestopping

A. Work, in general, includes furnishing and installing fire and smoke barrier penetration seals for openings in floor, walls, and other elements of construction.

B. Comply with requirements in Division 07 Section "Penetration Firestopping."

C. Comply with TIA/EIA-569-C, Annex A, "Firestopping."

D. Comply with BICSI TDMM, "Firestopping Systems" Article.

E. Applicator Qualifications: Two years’ experience installing UL classified firestopping.

F. Performance of materials will have been tested to provide fire rating equal to that of the construction.

G. Existing Project Conditions:

1. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
2. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.

H. Environmental Requirements:

1. Furnish adequate ventilation if using solvent.
2. Furnish forced air ventilation during installation if required by Manufacturer.
3. Keep flammable materials away from sparks or flame.
4. Provide masking and drop cloths to prevent contamination of adjacent surfaces by firestopping materials.

I. Warranties: Submit copies of written warranty, minimum of one year, agreeing to repair or replace joint sealers which fail in joint adhesion, cohesion, abrasion residence, weather resistance, extrusion residence, migration residence, stain resistance, or general durability or appear to deteriorate in any other manner not clearly specified by submitted Manufacturer’s data as an inherent quality of the material for the exposure indicated. The guarantee period will be one year from date of substantial completion.

J. Acceptable Manufacturers: Subject to compliance with requirements, provide products of Nelson Fire Protection Products or Engineers approved equal.

K. Materials:

1. Provide materials classified by UL to provide Fire Barrier equal to time rating of construction being penetrated.
2. Provide asbestos free materials that comply with applicable codes and have been tested in accordance with UL 1479 or ASTM E-814.

L. Preparation: Clean surfaces to be in contact with penetration seal materials of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.

M. Installation:

1. Install penetration seal materials in accordance with printed instructions of the UL Building Materials Directory and in accordance with Manufacturer's instructions.
2. Seal holes or voids made by penetration to ensure an effective smoke barrier.
3. Where floor openings without penetrating items are more than four inches in width and subject to traffic or loading, install firestopping materials capable of supporting same loading as floor.
4. Protect materials from damage on surfaces subject to traffic.

N. Field Quality Control:

1. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas.
2. Keep areas of work accessible until inspection by applicable code authorities.
3. Perform under this section patching and repairing of firestopping caused by cutting or penetration by other trades.

O. Adjusting and Cleaning:

1. Clean up spills of liquid components.
2. Neatly cut and trim materials as required.
3. Remove equipment, materials and debris, leaving area in undamaged clean condition.

3.6 Sealing of Penetrations and Openings

A. All firestop systems will be installed in accordance with the Manufacturer's recommendations and will be completely installed and available for inspection by the local inspection authorities prior to cable system acceptance.

B. Provide a seal around raceways or cables penetrating full height walls (slab to slab), floors or ventilation or air handling ducts so that the spread of fire or products of combustion will not be substantially increased.

C. Penetrations through fire-resistant-rated walls, partitions, floors or ceilings will be fire stopped using approved methods and NRTL listed products to maintain the fire resistance rating.

D. Installation restrictions of the listing agencies will be strictly adhered to e.g. 24 inch minimum horizontal separation between boxes on opposite sides of the wall, maximum square inch opening in wall.

E. Fire stopping in sleeves or in areas having small openings that may require the addition or modification of installed cables or raceways will be soft, pliable, non-hardening fire stop putty. Putty will be water resistant and intumescent.

F. Fire stopping in locations not likely to require frequent modification will be NRTL listed putty or caulk to meet the required fire resistance rating.

G. Box penetrations into a fire rated wall or shaft will have a fire-stopping pad installed on the back of the box.

H. Fire stopping of cable trays through walls will be with NRTL listed bags to meet the required fire resistive rating and that will not allow products of combustion to pass through the protected opening. The NRTL listed bags will be installed inside and on both sides of the opening as required to meet the required resistive fire rating of the wall.

I. Fire stopping materials will be NRTL listed to UL 1479 (ASTM E814). Installation methods will conform to a UL fire stopping system. Submit specifications and installation drawings for the type of material to be used. Fire stopping materials will be as manufactured by 3M, International Protective

Coatings Corp., Specified Technologies, Inc., Carborundum Company, RayChem, Nelson Fire Stop or approved equal.

3.7 Horizontal Copper Cable Installation

A. Common work for communication systems shall be installed in a neat and workman like manner. The NEIS Standard Practices for Good Workmanship in Electrical Contracting NECA 1-2006 and BICSI/TIA/EIA Telecommunications Cabling Installation Manual latest edition is hereby adopted to define such workmanship and the installation of communications equipment room fitting.

B. Each jack shall be cabled directly from the telecommunication room to the remote outlet location via the communications cabling pathway (no splices).

C. Wiring Method: Install horizontal cabling in raceways and cable trays except within racks, D-rings, on plywood backboard, cabinets, and except in accessible ceiling spaces where non-continuous cable support system may be used. Conceal raceway and cables except in unfinished spaces.

D. 10 ft. length X 12" diameter service loop shall be provided at work station location, above accessible ceiling.

E. Cables shall be bundled in like jacked color groups and general directions of cable paths.

F. Utilize D-ring and color-coded flexible straps at termination board for vertical and horizontal cable management.

G. Maximum horizontal cabling length: 295 feet.

H. The cable's manufacturer's minimum bend radius and maximum pulling tension shall not be exceeded.

I. Wire all jacks according to ANSI/TIA/EIA T568-B configuration.

1. The UTP cabling systems will have TIA/EIA T568B pin/pair termination assignment. All conductors provided will be properly and consistently terminated at both ends throughout the entire systems. Maintain proper untwist of pairs and removal of jacket per TIA and BICSI

J. Horizontal cabling shall be terminated such that wire pair twists are maintained as closely as possible to the point of mechanical termination. (No greater than 0.5" for category 5e or 6 cables.)

K. Horizontal wiring within equipment rooms and closets:

1. Bundle, lace, and train cables within cable tray / racks / D-rings.
2. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radius.
3. Provide and use wiring management.
4. Cable paths shall be installed in vertical and horizontal right angle configurations.

L. Terminations:

1. Voice: Patch Panels.
2. Data: Patch Panels.

M. Provide cross-connect cable / patch cords for the voice system for Owner provided telephone equipment.

N. Provide cross-connect cable / patch cord for the data system for Owner provided data equipment.

O. Securely mount equipment racks / cabinets per manufacturer's recommendations.

P. Provide 25% spare capacity at copper cross-connect blocks, patch panels, and cable management system for future expansion.

3.8 Faceplates Installation

A. All face plates shall be installed in a vertically plumb position, if this is not possible, notify other trades for corrective action.

B. Excess cable service loops shall not be stored in back box, cables should be pulled back into ceiling space.

C. All un-used plate opening shall be filled with blanks.

D. All face plates locations shall be labeled according to specification section Identification for Electrical Systems.

3.9 TELECOMMUNICATION EQUIPMENT ROOM INSTALLATION

A. 25ft Service Loops for all backbone cables / cable types shall be provided at each communication room or closest. The cable shall be neatly bundled and stored on wall or in ceiling for future expansion.

B. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools

C. Equipment Racks and Panels

1. Securely mount equipment cabinet and racks to the building structure. Proper supports such as 3/8" lag screws and expansion anchors will be used. Proper quantity of supports will be utilized. Dry wall screws and other types of supports not specifically approved to support equipment are specifically prohibited. Submit mounting supports for approval before installation.
2. Equipment cabinet mounted on or against walls will have 3-foot clearance in front of deepest component.
3. Patch Panels: Mount patch panels into the cabinet/rack in top-to-bottom fashion with the first patch panel (Fiber) mounted at the top of the “Active” equipment rack. Uniquely label each patch panel according to the numbering convention outlined in the SECTION on labeling. Each port will also have color-coded identifiers. Refer to details on the Drawings.
4. Cable Management: Secure the cable bundle(s) to the rack strain relief and cable management behind the patch panels and cross connect block panels. Install horizontal cable management panels and brackets for routing and management of patch cables. Maintain TIA/EIA and BICSI standards on bundling, supporting and bend radii.
5. Surge Protected Outlet Strips: Mount surge protected outlet strips per Manufacturer’s directions. Refer to details on the Drawings for mounting location.

D. Bonding and Grounding:

1. See specification Section 26 05 26.
2. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
3. Cabinet and racks shall have dedicated bonding connection for proper grounding according to ANSI-J-STD-607-B.
4. Bond metallic equipment to the grounding bus bar, using not smaller than No. 10 AWG equipment grounding conductor.

E. Copper backbone cable shall be landed on a 110 style cross field. Terminated to 568B wiring specifications.

F. Cable shall be terminated on the same category rated blocks or higher than the installed cable.

G. A trough Style cable management system for cross connecting blocks shall be provided.

H. The cross connect field shall be designed for 25% growth, for future changes.

I. All communications equipment racks, cabinets, backboards and other termination hardware shall be labeled at the top left hand corner of each piece of equipment. With a minimum ¾” high identification label, identifying the room and rack location numbering system.

J. All communication copper and fiber patch panels shall be labeled with a minimum 3/8” high identification label identifying panels and sequential port numbering system.

3.10 Backbone Cable Installation

A. Unless noted otherwise backbone cables shall be installed conduit pathways. All cables not in raceways shall be riser or plenum rated.

B. Backbone cables shall be grouped separately from horizontal distribution cables. Cable for other systems shall be grouped separately from cables for telephone and data

C. Unless noted, all interior wiring shall be installed in raceways

D. Each cable run between terminating locations shall be one continuous cable (no splices or connections). No mid span fiber spicing shall be permitted on backbone cable runs.

E. All wires shall be marked at all junction boxes, pull boxes, cabinets, boxes and terminations.

F. The Contractor shall install cable in such a manner as to prevent stretching, kinking or sharp bends. Cable damaged during installation or not passing required testing shall be removed and replaced at no additional cost to Owner

G. The Contractor shall replace or rework cables showing evidence of improper handling including stretches, kinks, short radius bends, over tightened bindings, loosely twisted and over twisted pairs at terminations, and too much jacket removed

H. Minimum bend radius and maximum pulling tension for all cables shall be maintained during and after installation. Install cable in accordance with manufacturer's ratings and instructions

I. The armoring of cable shall be maintained into the fiber termination cabinet and used as the cable restraint. The armor shall be also be properly grounded.

J. Installation of Backbone cable within the ER:

1. The cable shall be secured to the ER wall or other specified location using Velcro cable wrap brackets.
2. Cables shall be neatly bundled with hook and loop type fasteners. Nylon tie wraps are not acceptable. Cables must be neatly bundled in the telecommunications spaces and at the cable service loop
3. The end of the cable, exclusive of the coil of slack, shall be routed to the splice housing mounted within the equipment rack for furcation and termination.
4. Leave a maximum of 6 feet of buffer tube in the fiber optic enclosures. Secure the cable to the wall or equipment frame using Velcro cable wraps.
5. Cables shall be routed as close as possible to the ceiling, floor, or corners to insure that adequate wall or backboard space is available for current and future equipment and for cable terminations. Cables shall not be tie-wrapped to existing electrical conduit or other equipment. Minimum bend radius shall be observed
6. Dress and attach cables to the backboard along the shortest possible route run square (horizontal and vertical) to the backboard. Bundle similarly routed cables together and attach by means of clamps or distribution rings. Cable dress and attachment shall minimize obstruction to future installations of equipment, backboard, or other cables

K. Cable service loops shall be provided at both ends of backbone cable runs:

1. At the telecommunications room, provide a minimum 8 foot service loop stored in a figure eight pattern in the cable tray above the racks/cabinets.
2. At the telecommunications room, provide sufficient slack to properly dress and terminate cables at the racks and cabinets
   a. Provide sufficient slack so that swing gate type racks and cabinets can open fully
   b. Provide sufficient slack so that cables do not catch or bind at swing gate type rack or cabinet hinge and the cables do not pull taught across the hinge or edge
3. A minimum 25 foot service loop shall be maintained at each building entrance and exit

L. A break-away link shall be used for installation of cables with a cable-puller or winch. The break-away link shall be designed to separate at or below the recommended maximum tension of the cable being installed

M. Any damage to Owner’s existing cabling or existing cable owned by others, caused as a result of work performed under this scope, shall be brought to the Owner’s attention and repaired or replaced within 48 hours.

N. Contractor shall use only cable lubricants recommended by the manufacturer for use with the specific cable construction.

O. Should a cable become kinked, skinned or stretched during installation, the cable shall be removed and replaced at no additional cost to the Owner. Splicing at points other than those specified will not be acceptable.

P. Furcation of Fiber Optic Cable: Prior to termination, fiber optic cable strands will be furcated (fanned out) using the specified furcation kits and using the procedure specified by the manufacturer.

Q. Termination of Fiber Optic Cable

1. Where specified, the Contractor shall terminate the individual fiber strands with connectors according to the manufacturer's specifications.
2. Upon final testing, mated-pair connector attenuation shall not exceed 0.75 dB. Connectors which exceed this level of attenuation shall be cut off and fibers re-terminated by the Contractor.
3. Terminated fibers shall be installed within a fiber termination panel mounted within an equipment rack, as specified on the Drawings.

3.11 Identification

A. See Section - Identification for Electrical Systems for additional product information.

B. All components of the structured cabling system shall be labeled including but not limited to cables, connecting blocks, patch panels, racks, cabinets, and outlet plates.

C. Identification conventions shall match the Owner's current labeling convention. If there is no current labeling convention or the current convention is no longer adequate the following shall be used.

D. Cables shall be identified at each end. Same designation shall be used at both ends.

1. A basic labeling convention of sequential numbering shall be used.
2. Provide wire markers as follows for horizontal UTP copper cabling in the following format
   a. Telecommunications Room Name / Outlet Room Number / Cable Function / Faceplate Number

   b. Example: TTTT / XXXX / D (for Data) or V (for Voice) / 01-99

   c. Label cables within outlet boxes and within 4" of each termination.

E. Outlet faceplates shall be identified.

1. Room number - faceplate sequence within room (clockwise from north) - X# where X indicates use (D for data, V for voice, W for wi-fi, C for coax CATV) and # is the jack sequence (clockwise from top right).

F. Racks shall be identified as indicated on Drawings. If not designation are made on the Drawings submit an RFI with suggested naming convention.

G. Rack mounted termination equipment (patch panels, IDC connectors, fiber enclosures, etc.) shall be identified by color (as noted in BICSI TDMM) and by row within termination field, and by position within a particular terminal block or patch panel, etc.

3.12 General Quality Control

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

C. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

D. Protect installed products until completion of project.

E. Touch-up, repair damaged products before Substantial Completion.

F. The engineer reserves the right to a 10% random retest of horizontal station cables at no additional cost to the Owner.

G. Failure to meet industry test standards will require the contractor replace non-performing components at their own exposure.

H. After installation, equipment will be protected to prevent damage during the construction period. Openings in conduits and boxes will be closed to prevent the entrance of foreign materials.

3.13 Horizontal Copper Cabling Field Quality Control

A. Communications horizontal copper cabling shall be 100% tested.

B. Field Testing Equipment: Submit during shop drawing review on the testing equipment to be utilized on this project. The installer shall test all cables installed under this Section

1. The cable tester shall have a wide variety of preprogrammed cable types as an integral part of its testing system and have the ability to test cables less than 6 feet (6ft.) from the test point.
2. Testing shall be accomplished using level III or higher field tester that is loaded with the most current version of test software by the manufacturer of the test equipment.
3. Provide factory calibration report of field test equipment.

C. Testing Procedure:

1. Testing shall conform to ANSI/TIA-568-C.0 standard.
2. Testing will be to the Permanent Link Test Parameters.
3. Test each pair and shield of each cable for opens, shorts, grounds, and pair reversal. Correct grounded and reversed pairs. Examine open and shorted pairs to determine if problem is caused by improper termination. If termination is proper, tag bad pairs at both ends and note on termination sheets.
4. Test each UTP cable and passive components. Provide certification that entire installation of UTP cabling, equipment and jacks are NRTL certified meeting or exceeding a minimum of category performance specified on all four pairs of conductors.
5. Tests shall be based on each pair of conductors and not the aggregate multiple pair results.
6. Test all installed cable segments end-to-end, from the telecommunications room horizontal patch panel/cross connect block panel to each work area outlet and from each telecommunications room backbone patch panel/cross-connect block panel to respective main cross connect, and from the work area outlet to the main cross-connect (through patch cables or cross- connect wiring) with a Signal Injector, Graphical Link Testing Meter and Time Domain Reflectometer (TDR) for compliance to latest TIA performance requirements, as well as NEXT, ELFEXT, structural return loss, alternating power sum, opens, shorts, continuity, cable length, and characteristic impedance.
7. Provide report indicating failures and what actions were taken to ensure a passing horizontal cable and its terminations. Any cable failing the certification test (Fail, Fail* or, Pass*) must have remedial work done to provide a full pass test result; Remediation may include retermination or replacement of the cable, which fails. No cables passing within tolerance only (Conditional Pass*) will be accepted.

D. Test results:

1. The test results information for each link shall be recorded in the memory of the field tester upon completion of the test. The tester shall be capable of storing test data in either internal or external memory. The external media used shall be left to the discretion of the user.
2. Test results saved by the tester shall be transferred into a Windows based database utility that allows for maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered as well as any printed reports generated from the software application.
3. Optional formats of data reporting are: comma separated variable (.csv), Portable Document File (.pdf) or compatible, plain text (.txt), or hypertext markup language (.html/.htm).
4. Test Results shall include the following:
    a. Applicable Telecommunications Room number
    b. Circuit I.D. number with corresponding jack identifier
    c. Wire Map - shall include the following:
        1) Continuity to the remote end
        2) Shorts between any two or more conductors
        3) Crossed pairs

4) Reversed pairs

5) Split pairs

6) Any other miswiring

d. Length

e. Insertion Loss

f. Near-end Crosstalk (NEXT) Loss

g. PS-NEXT (Power Sum Near End Cross Talk)

h. ELFEXT (Equal Level Far End Cross Talk)

i. PS-ELFEXT (Power Sum Equal Level Far End Cross Talk)

j. Propagation Delay

k. Delay Skew

l. Return loss

3.14 Backbone Cable Field Quality Control

A. On completion of the cable installation and termination the cable shall be tested before put into use.

B. Fiber Optic Cable Testing

1. Test Equipment:
   a. Cable tester will be NRTL certified for EIA/TIA TSB95.

   b. Cable testers will be Optical Power Meter and High Resolution Optical Time Domain Reflectometer (OTDR). The cable tester will be NRTL certified for compliance to latest TIA/EIA Standard 568B performance requirements at 850, 1300 and 1550 nm

   c. Testers will have been calibrated at least one year prior to use on this project. Contractor to provide proof to Owner if requested

   d. All testing equipment (OTDR, Light Loss, Splicer etc.) will be owned by the Contractor. Contractor must prove ownership of equipment if requested

2. Cable segments and links will be tested from both ends of the cable for each of the construction phases
3. The system will not be considered certified until the tester has acknowledged that the performance of the physical layer of the system has been fully tested and is operational at the completion of the installation phase.
4. Test Procedure
   a. Perform each visual and mechanical inspection and electrical test, including optional procedures, stated in NETA ATS, Section 7.25. Certify compliance with test parameters and manufacturer's written recommendations. Test optical performance with optical power meter capable of generating light at all appropriate wavelengths

   b. Prior to testing, all connectors will be properly cleaned with an approved product manufactured specifically for this purpose

c. Prior to beginning testing, confirm that all testing equipment is fully charged or operating on building power. If the test equipment power levels drop below 50%, recharge unit or continue testing with a different (fully charged) tester

d. Initially test optical cable with a light source and power meter utilizing procedures as stated in TIA TSB-140, ANSI/TIA/EIA-526-7, ANSI/TIA/EIA-526-14A, OFSTP-14A Optical Power Loss Measurements of Installed Multi-mode Fiber Cable Plant and ANSI/TIA/EIA-526-7 Measurement of Optical Power Loss in installed Single-Mode Fiber cable plant

e. Measured results will be plus/minus 1 dB of submitted loss budget calculations. If loss figures are outside this range, test cable with Optical Time Domain Reflectometer (OTDR) to determine cause of variation. Correct improper splices and replace damaged cables at no charge to the Owner

5. Multi-Mode Fiber Optic Cables
   a. Will be tested bi-directionally for length and attenuation at both the short and long wavelengths for Multi-Mode (850 and 1300 nm). This is Tier 1 testing as specified in TIA TSB-140. Test all Multi-Mode strands to ensure they are capable of transmitting 10 Gigabit Ethernet speeds

   b. The maximum insertion loss measured at 23 degrees C. will be 3.75dB/km @ 850 nm and 1.5 dB/km @ 1300 nm

6. All cables will be tested after termination using a cable certification tester that contains the test equipment manufacturer's most current version of firmware.
7. Test all fiber optic cable segments end-to-end from the fiber optic backbone patch panel in the Equipment Room to each fiber optic backbone patch panel in each Telecommunications Room.
8. Broken or faulty strands will not be accepted. Any cable not fully functional with all strands usable will be replaced at no cost to the Owner.
9. Upon completion of testing, all connectors will be capped with a product made for that specific function by the connecting hardware manufacturer to prevent the contamination of the fiber from construction debris or other foreign objects
10. Test results will include the following:
    a. Telecommunications Room number

    b. Location of fiber pull i.e. (Equipment Room # to Telecom Room #)

    c. Patch panel # and location

    d. Connector type

    e. Distance

    f. Wavelength tested

    g. Technician who performed the testing

3.15 Owner Instruction and demonstration

A. Provide a complete review of the project and systems including, but not limited to, the following:
   1. Review each Record Drawing (use of typicals is acceptable).
   2. Note equipment layouts, locations and control points.
   3. Review each system.
   4. Review system design operation and philosophy.

5. Review alarms and necessary responses.
6. Review standard troubleshooting techniques for each system.
7. Review areas served by equipment.
8. Identify color codes used.
9. Review features and special functions.
10. Review maintenance requirements.
11. Review operation and maintenance manuals.
12. Respond to questions (record questions and answers).

B. Conduct walking tour of Project and briefly describe function, operation, and maintenance of each component after training described above.

3.16 Documentation

A. Provide written certificate(s) and include a copy with the O&M manuals, indicating that the inspections and tests specified herein have been performed, that Owner Training and Demonstration, and that the installation is in accordance with these specifications. Certificate shall be signed and dated by Contractor.

B. Publish testing results in book format and electronically and include with Operation and Maintenance Manual.

3.17 Cleaning

A. Provide final cleaning, protection, and maintain conditions in a manner acceptable to manufacture, which ensures system being free form damage and deterioration at time of Substantial Completion.

B. In all telecom room spaces - a thorough sweeping, vacuuming and wet mopping shall be performed on a weekly basis or more frequently as directed by the owner. Cleaning shall include floors, rafters, floor joists, exposed structural members, exposed mechanical/electrical equipment and ductwork/piping/conduits, walls, ladder trays, tops of cabinets/racks, existing/new passive and active components, or per manufacturer recommendations.

C. All non-metallic cable managers and snap covers shall be wiped clean, both inside and outside of front, including rear channels. All clear covers and doors shall be cleaned, both front and rear per manufacturer recommendations.

D. Inside of fiber optic enclosure and patch panels shall be blown clean of settled dust. Cleaning shall be performed for all new construction projects or where gypsum sanding has been performed.

E. All scraps, boxes, spools, pull-line and trash shall be removed and properly disposed of.

F. All residual cable lubricant shall be cleaned from floors and walls with an appropriate degreaser.

3.18 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Comply with inspection and testing requirements of specified installation standards.

C. Visual Inspection:

1. Inspect cable jackets for certification markings.
2. Inspect cable terminations for color coded labels of proper type.
3. Inspect outlet plates and patch panels for complete labels.

D. Testing - Copper Cabling and Associated Equipment:

1. Category 5e and Above Links: Perform tests for wire map, length, attenuation, NEXT, and propagation delay.

E. Testing - Fiber Optic Cabling:

1. Backbone: Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests.
2. Multimode Backbone: Perform tests in accordance with TIA-526-14.

F. Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

END OF SECTION

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SECTION 27 51 20 - GYM SOUND SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Gym Sound System.
   1. All equipment required for fully-functional gym sound system.

1.2 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.3 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate electrical characteristics and connection requirements. Indicate layout of equipment mounted in racks and cabinets, component interconnecting wiring, and wiring diagrams of field wiring to speakers and remote input devices.
C. Product Data: Provide data showing electrical characteristics and connection requirements for each component.
D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
E. Operation Data: Include instructions for adjusting, operating, and extending the system.

PART 2 PRODUCTS

2.1 Gym Sound System

A. Basis of Design for entire gym sound system: As indicated on drawings.
B. Relay for Fire Alarm System override.
C. Relay for Intercom System override.

2.2 Wire and cable

A. Microphone Cable: 20 AWG stranded copper conductor, 600 volt insulation, rated 60 degrees C, two conductor shielded cable with rubber jacket.
B. Input Cable: 22 AWG copper conductor, 300 volt insulation, rated 60 degrees C, paired conductors twisted together, shielded, and covered with a PVC jacket.
C. Speaker Wire and Cable: 14 AWG copper conductor, 300 volt insulation, rated 60 degrees C, paired conductors twisted together and covered with a PVC jacket.
D. Plenum Cable for Speaker Circuits: 14 AWG copper conductor, 300 volt insulation, rated 200 degrees C, paired conductors twisted together shielded and covered with a nonmetallic jacket; suitable for use for Class 2 circuits in air handling ducts, hollow spaces used as ducts, and plenums

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Provide all necessary wiring to make the system functional.
C. Leave 18 inches excess cable at each termination at microphone, volume pad, speaker, and other system outlet.
D. Leave 6 feet excess cable at each termination at system cabinet.
E. Wiring in exposed areas to be installed in conduit.

F. Connect reproducers to amplifier with matching transformers.

G. Install equipment racks in location shown; arrange to provide adequate ventilation and access.

3.2 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

3.3 SYSTEM STARTUP

A. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.

3.4 CLOSEOUT ACTIVITIES

A. Demonstration: Demonstrate operation of system to Owner's personnel.

1. Use operation and maintenance data as reference during demonstration.
2. Briefly describe function, operation, and maintenance of each component.

B. Training: Train Owner's personnel on operation and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Location: At project site.

END OF SECTION

SECTION 28 00 00 - ELECTRONIC SAFETY AND SECURITY GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical General Requirements specifically applicable to Division 28 Sections, in addition to Division 01 - General Requirements.

B. Definitions common to Division 28 specification sections.

1.2 RELATED DOCUMENTS

A. Drawings, addenda and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification Sections, apply to this and all other sections of Division 28.

B. This section is related to all other sections of Division 28.

1.3 DEFINITIONS

A. Words "Architect" where written in Division 28 specifications and drawings refer to commissioned Design Professional, whose name appears on contract documents.

B. Word "Engineer" where written in Division 28 specifications and drawings refers to Consulting Electrical Engineer, CMTA, Inc., 311 Fourth Street South, Suite #110, Grand Forks, ND, 58201; phone (701)775-2594, facsimile (701)775-0231.

C. Word "Contractor" where written in Division 28 specifications and drawings refers to Electrical Contractor and any and all of his subcontractors.

D. Word "Material" where written in Division 28, specifications and drawings shall mean any and all apparatus, equipment, devices, fixtures, components, products, assemblies, items, parts, things, and any other pieces specified or shown or required.

E. Word "Labor" where written in Division 28 specifications and drawings shall mean any and all physical effort, manpower, time, expertise, tools, equipment and services to carefully assemble, install and affix all material in a proper, complete and acceptable manner.

F. Word "Provide" where written in Division 28 specifications and drawings shall mean "Electrical Contractor shall furnish all labor and material and completely and properly install such material and leave same in acceptable condition and intended acceptable working order".

G. Performance Verification Testing refers to test performed in the field to ensure proper operation and / or installation of service or products.

1. Unless noted otherwise Performance Verification Testing is not required to be provided by a 3rd party testing firm.
2. Unless noted otherwise Performance Verification Testing is not required to be witnessed by the Electrical Engineer, Owner, Architect, and / or (if applicable) Commissioning Agent

H. Acceptance Testing refers to formal testing process required prior to acceptance by the Owner.

1. Unless noted otherwise Acceptance Testing is required to be provided by a 3rd party testing firm.
2. Unless noted otherwise Acceptance Testing is required to be witnessed by the Electrical Engineer, Owner, Architect, and / or (if applicable) Commissioning Agent.

I. As-built drawings are prepared by the contractor. They show, in red ink, on-site changes to the original construction documents.

J. Record drawings are prepared by the Architect or Engineer and reflect on-site changes the contractor noted in the as-built drawings.

K. Quality Assurance includes all the planned and systematic activities implemented that can be demonstrated to provide confidence that a product or service will fulfill requirements for quality. Typically, quality assurance procedures are performed before and while the work is being performed. As such in the Division 28 specifications Quality Assurance procedures are specified in Part 1.

L. Quality Control includes all the planned activities required to verify quality after the work has been performed. This can include testing and inspections along with other procedures. As such in the Division 28 specifications Quality Assurance procedures are specified in Part 3.

1.4 SCOPE OF WORK

A. All Specifications, corresponding Drawings and all Addenda form a complete set of documents for electrical work for this project, and no part shall be considered complete without the other.
   1. SPEC WRITER'S NOTE: A performance spec is written requirement that describes the functional performance criteria required for a particular equipment, material, or product. A design specification describes design characteristics and manufacturing methodology. Our specifications include aspects of both.

B. The Specifications, Drawings, and all Addenda describe both the design characteristics and functional performance criteria that the completed electronic safety and security systems shall include.

C. Contractor shall obtain all required licenses, permits, plan reviews, inspections and pay all fees, costs and all other charges for this project. All sales, use and any other taxes shall be paid by Contractor.

D. Electrical Work shall comply with all ordinances, laws, regulations and codes applicable to the work involved. If, in any instance, the plans and specifications conflict with such laws, the stricter requirement shall take preference.

E. If Contractor is aware of conflicts between drawings or specifications and such codes or regulations, they shall be brought to the Engineer's attention prior to commencing work. If Contractor performs work in violation of such codes or regulations, Contractor shall correct the violation at his expense.

F. Work under Division 28 includes providing all labor and materials necessary for satisfactory completion of all electrical work shown on all drawings and in all specification divisions. In general, this consists of the following:
   1. Electronic Safety and Security Systems.
   2. Other systems specified, indicated, or shown.

G. Site Investigation
   1. Prior to submitting bids, visit the work site to become familiar with existing conditions which may affect the cost of the project. This includes measurements for lengths, quantities, clearances and all other field verifiable conditions.
   2. No extra charges will be allowed because of failure of Contractor to become familiar with all existing conditions.
   3. Where work under this project requires extension, relocation, or modifications to existing equipment, systems or installations the existing equipment, system or installations shall be restored to their original condition, with exception to the work under this project, before completion.
   4. Existing equipment, systems and installations which are not detailed on the drawings must still be restored to their original condition.

1.5 ALTERNATES

A. SPEC WRITER NOTE: Discuss this information with architect. This may be noted in Division 01.

B. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the Owner's option. Accepted Alternates will be identified in Owner-Contractor Agreement (contract).

C. Coordinate related work and modify surrounding work as required.

D. Schedule of Alternates: See Division 00 and Division 01.

1.6 DRAWINGS

A. Drawings indicate the extent and general layout of the Electronic Safety and Security systems.

B. The electrical drawings are diagrammatic (that is, designed to demonstrate or explain the scope of work), they are intended to be as accurate as planning can determine.

C. The scales are shown for estimating purposes only. Field verification of dimensions, locations, and construction details is required. Review appropriate drawings (for example: shop drawings), make field

measurements and adjust work to suit the conditions encountered. Although electrical drawings are diagrammatic, they shall be followed as closely as actual construction permits.

D. Contractor shall coordinate with civil, architectural, structural, and mechanical construction drawings for locations of partitions, walls, beams, shafts, equipment, etc.

E. DO NOT SCALE LOCATIONS OF DEVICES FROM ELECTRICAL DRAWINGS.

F. Standard electrical symbols along with special symbols are used on all drawings.

1.7 REGULATORY REQUIREMENTS

A. SPEC WRITER NOTE: Coordinate this code information with the Architect. The Architect should perform and provide us with a Code Study indicating which codes apply to this jurisdiction.

B. Work provided shall comply with the following partial list of governing codes and regulations:

1. International Building Code (IBC).
2. International Fire Code. (IFC).
3. State Fire Codes.
4. State and Local Electric Codes.
5. State Building Code.
6. Serving Utility Regulations.
7. National Fire Protection Association (NFPA) National Fire Codes.
   a. NFPA 70 - National Electrical Code.
   b. NFPA 72 - National Fire Alarm and Signaling Code.
   c. NFPA 101 - Life Safety Code.
8. Williams-Steiger (OSHA) Regulations.
9. Americans with Disabilities Act (ADA) requirements.
10. State Health Department Requirements

1.8 QUALITY ASSURANCE

A. Notify the Architect or Engineer of any discrepancies in or omissions from the drawings and documents. Interpretations and clarifications during bidding will be made only by written Addenda. If discrepancies are not reported, the contractor shall bid the greater quantity or better quality, and appropriate adjustment will be made after contract award.

B. Any work not clear to Contractor shall be referred to Architect or Engineer for clarification before bid is submitted. If no question is raised prior to opening of bid, Contractor shall be required to provide work, in question, as directed by Architect or Engineer, whose decision shall be final, without additional charges.

C. By virtue of submitting a bid, Contractor agrees that he is skilled and experienced in use of and in interpretation of drawings and specifications. Contractor further agrees that he has carefully reviewed all drawings, all specifications and all addenda, which constitute bid documents for this contract, and finds them free of ambiguities and good and sufficient for bidding and construction purposes.

D. Should major changes from drawings and specification be necessary, Contractor shall provide notification and secure written approval and agreement concerning such changes before work is started.

1.9 WARRANTY

A. The Electrical Safety and Security Contractor shall guarantee that all materials and equipment included in their work are free of defects caused by flawed workmanship, material or equipment failures.

B. The warranty guarantee shall extend one year minimum from the date of final acceptance of the work or for as long as normal equipment manufacturer warranties are in effect from the date of final acceptance of the work.

C. During the warranty period, the Electrical Safety and Security Contractor shall respond by making appropriate corrections or repairs required to correct defect within one week of notification. Notification shall be made by telephone, fax, email, or letter.

D. The Electrical Safety and Security Contractor shall provide 24-hour service in case of emergency.

1.10 SUBSTITUTIONS

A. Where substitute materials or prior approved materials are provided, Contractor shall assume all responsibility and pay for all necessary changes resulting from such substitution. This responsibility shall also include any extra costs required by other trades.

B. Required where specifically noted or where materials are specifically identified by a manufacturer's name, model or catalog number. In these cases only such material may be included in base bid. Prior approval of substitute materials shall be required.

C. Prior approved substitutions:

1. Requests for prior approval shall be made in accordance with Division 01, as specified below, and indicated in specific specification section.
2. If Contractor desires to furnish materials other than that named, Contractor or supplier shall apply in writing, to Architect, for prior approval of such material at least ten (10) days prior to bid opening date.
3. Requests for prior approved substitution shall indicate specific proposed materials in lieu of those specified together with complete technical data for all such proposed material.
4. All prior approved substitutions will be clearly identified in addenda which will be sent to all bidders well in advance of bid opening. Only material listed on drawings, specifications and addenda shall be provided.

D. Substitutions after execution of contract: Substitution of materials other than those specifically named in contract documents will be approved, by Architect or Engineer, for following reason only:

1. That material proposed for substitution is equal to or superior, in Engineer and Architect's opinion, to that specified in construction, efficiency, appearance, and utility.
2. That material named in the documents cannot be delivered to project in time to complete work due to conditions beyond control of Contractor.

E. Equal To and Or Equal: Where materials are specifically identified as “equal to” an identified manufacturer’s name, model, or catalogue numbers or where noted as “or equal” manufacturer’s complying with the requirements of these specifications not listed may be incorporated in the Work. Such materials must be equal to or superior, in Engineer’s opinion, to that specified in construction, efficiency, appearance, and utility.

1.11 GENERAL REQUIREMENTS FOR SUBMITTALS

A. Submit according to the requirements of Division 01.

B. General requirements for Submittals for Review

1. Submittal format, general information, and requirements for all submittals:
   a. At the front of the submittal on a dedicated page(s): name, address, and phone number of equipment vendor, engineer, and contractor.

   b. At the front of the submittal on dedicated page(s): Any deviation from contract requirements shall be called to attention. No deviation will be permitted without written approval of Architect or Engineer.

   c. At the front of the submittal on dedicated page(s): Any requests for clarification, selections that must be made, etc. shall be called to attention.

   d. At the front of the submittal on a dedicated page(s): Include a complete list of equipment included with manufacturer and model number or catalog number.

e. Submittals shall be grouped to include complete information for related systems, products, and accessories in a single submittal with tabs, dividers, or other means of separating each different component within the submittal from the next.

f. Mark dimensions and values in units to match those specified.

g. Drawings and brochures shall be clearly marked as to item to be supplied and shall have designation corresponding to designation on Drawings (for example: enclosed switch data shall indicate for which equipment they are provided).

2. Contractor Review of Submittals

a. The Contractor shall thoroughly review each item for compliance with these Specifications making any necessary corrections prior to issuing submittal. Each submittal set shall be stamped, signed and dated indicating Contractor review. If the Contractor fails to properly review submittals, the Contractor shall reimburse the Engineer for all additional reviews on a time and material basis.

b. Should the contractor fail to comply with any of the requirements of the specified submittal requirements; then the right is reserved by the Architect or Engineer to select any or all items in the material schedule, with that selection to be final and binding upon the contractor. The materials selected or reviewed, as the case may be, by the Architect and / or Engineer, shall be used in the work at no additional cost to the Owner.

3. Architect / Engineer Review of Submittals

a. The submittal will be reviewed with reasonable promptness, and returned to the Contractor (with copies retained by the Engineer and the Architect). No equipment should be released for shipment until submittals have been approved.

b. Submittal review is to verify general conformance with the design concept of the Project and substantial compliance with the information provided in the Contract Documents. This review does not in any way relieve the Contractor or their suppliers of their responsibility to provide all materials and equipment as specified, in quantities, quality and dimensions required.

c. Approval Stamp: Submittals will be reviewed with the following actions noted:

1) “No Exception Taken” indicates that the Submittal appears to conform to the design concept of the Work and that the Contractor, at his discretion, may proceed with fabrication and/or procurement and installation.

2) “Reviewed as Noted” indicates that the Submittal, after noted corrections are made, appears to conform to the design concept of the Work and that the Contractor, at his discretion, may proceed with fabrication and/or procurement and installation, if the corrections are accepted by the Contractor without an increase in Contract Sum or Time.

3) “Revise and Resubmit” indicates that the noted revisions are such that a corrected copy of the Submittal is required for review to confirm that the noted revisions have been understood and made. The Contractor, at his discretion, may proceed with fabrication and/or procurement and installation after submitting a corrected copy and verifying with the reviewer that the corrected copy is acceptable, if the

corrections are accepted by the Contractor without an increase in the Contract Sum or Time.

4) "Rejected" indicates that the Submittal does not appear to conform to the specifications, a resubmission is required and fabrication or procurement is not authorized.

4. If the Architect or Engineer rejects (Revise and Resubmit or Rejected) the same section two times the engineer shall be compensated for additional reviews (beyond the first two) at a rate of $500 per review. Compensation will be incorporated by Change Order and will be deducted from the Contractor's application for payment. Contractor is responsible for all delays caused by the resubmittal process

C. General Requirements for Submittals For Information
   1. Information submittals shall include the information noted in the specifications and information requested by the Architect, Engineer, and / or Owner.
   2. Coordination Drawings: Where this and other specification sections require Coordination Drawings to be submitted meet the requirements defined in Division 01 and as indicated below.
      a. Prepare documents using software program required by Division 01. If no requirements are listed utilize a software compatible with AutoDesk's AutoCAD.

      b. Submit hardcopies and / or electronic copies as required by Division 01. Drawings and files shall be uniquely labeled.

      c. Scale shall not be less than 1/8" equal 1 foot.

D. General Requirements for Submittals for Closeout:
   1. As specified in Division 01 and Section 28 0100.

E. General Requirements for Product Data. The following are minimum requirements.
   1. Catalog sheets showing ratings, settings, performance curves and rated capacities.
   2. Dimensions, locations, materials, fabrication details, finish.
   3. Outline and support, arrangement and sizes, roughing-in data, and accessories.
   4. Operational Characteristics.

F. General Requirements for Shop Drawings. The following are minimum requirements.
   1. Electrical ratings of equipment; how the components of the equipment are assembled and function together; and how they will be installed on the project.
   2. Dimensioned plans, elevations, sections, and details. Show quantities of installed devices, features, and ratings.
   3. Detail enclosure types.
   4. Detail configuration, current, and voltage ratings.
   5. Detail features, characteristics, ratings, and factory settings devices and auxiliary components.
   6. Include wiring diagrams for power, signal, and control wiring.

G. General Requirements for Manufacturer's Instructions. The following are minimum requirements.
   1. Application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements.
   2. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
   3. Instructions for placing each piece of equipment and system into operation.

1.12 PROJECT SUBCONTRACTOR AND VALUES LISTING

A. SPEC WRITER NOTE: This is in the spec so that we can get information from the contractor as to who is supplying materials and, who they are using for fire alarm, etc. We do not often enforce it or ask for this information but it is here if we need it.

B. Contractor shall submit, to Architect, a list indicating brands of all major materials, names of all of his subcontractors and a schedule of values for this project. Engineer reserves right to reject any material or subcontractor and question scheduled values.

PART 2 PRODUCTS

2.1 Not Used.

PART 3 EXECUTION

3.1 Not Used.

END OF SECTION

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SECTION 28 05 00 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This Section includes limited scope general construction materials and methods for application with electronic safety and security systems installations.

B. Materials specified herein include:

1. Concrete.
2. Miscellaneous for support of electrical materials and equipment.
3. Hangers and Supports.
4. Joint sealers for sealing around electrical materials and equipment; and for sealing penetrations in walls, floors, ceilings, roofs, foundations for moisture, water, smoke, fire and acoustic control.

C. General electric construction methods and requirements specified herein include:

1. Material and workmanship.
2. Product manufacturer requirements.
3. Coordination.
4. Safety.
5. Material handling, storage protection, cleaning and painting.
6. Cutting, patching and finishing.
7. Penetrations.
8. Wiring Methods.
9. Balancing Loads.
10. System Interruptions.
11. Outlet mounting heights.
12. Electrical demolition and remodeling.
13. Equipment Wiring (connections).
14. SPEC WRITER’S NOTE: Make sure Utility Company Coordination requirements are described well for projects where modifications to the existing service are required.

D. Owner Instruction and Demonstration.

1.2 RELATED DOCUMENTS

A. Drawings, addenda and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification Sections, apply to this and all other sections of Division 28.

B. This section is related to all other sections of Division 28.

C. Division 03 Section Cast-in-Place Concrete (Miscellaneous Cast-in-Place Concrete).

D. Division 03 Section Grouting.

E. Division 03 Section Concrete Boring (Concrete Core Drilling).

F. Section 28 0100 Electrical Systems Close Out Documentation.

1.3 ELECTRIC SERVICE DESCRIPTION

A. Serving Utility Company: Otter Tail Power Company

B. System Characteristics: As indicated on drawings.

1.4 REGULATORY REQUIREMENTS

A. See Section 28 0000.

1.5 **COMMON REQUIREMENTS FOR QUALITY ASSURANCE**

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years experience.

B. Installer Qualifications: Engage experienced Installers for Work.

C. 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 re-certification.

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

E. Standardization of Product Manufacturer:

1. When two or more items of same material or equipment are required they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, wire, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in Work, except as otherwise indicated.
2. Except as noted, all safety switches, and equipment shall be manufactured by the same company, all finishes shall be the same color, and all equipment shall fit the space designated.
3. Wiring devices and other items covered under a single specification section, shall be of the same manufacturer and style whenever practical or where failure to do so is visibly noticeable.

F. Material and Workmanship:

1. All materials provided shall be new and shall be approved by the Underwriters Laboratories, Inc., NFPA, NEMA, and ANSI as conforming to its standards in every case where such a standard has been established for such material.
2. Materials shall be standard products of manufacturer’s regularly engaged in the production of such equipment and shall be the manufacturer’s latest standard design.
3. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
4. All workmanship shall be neat and complete in both effectiveness and appearance and shall be executed by persons licensed and skilled in the trade. Engineer reserves the right to reject any material or workmanship before, during or after construction.
5. Materials and Finishes: Provide adequate corrosion resistance to eliminate staining of exposed surfaces.
6. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.

G. Coordination:

1. See also “Quality Assurance” paragraph of Section 28 0000.
2. Discrepancies and omissions discovered during construction shall immediately be called to the attention of the Architect or Engineer for clarification.
3. Installation of materials shall be coordinated with other trades and installed at such time and manner as to not delay or interfere with the work of other trades.
4. Obtain and review shop drawings, product data, manufacturer’s wiring diagrams, and manufacturer's instructions for equipment furnished under other sections. Determine connection locations and requirements.
5. Sequence and coordinate work with other trades so as to avoid conflict of space and time sequence. If interference develops, the matter shall be brought to the attention of the Architect for decision.
6. Organize the work so that progress of work will conform to the progress of other trades. Give particular attention to large equipment requiring positioning prior to closing the building.
7. Complete the entire installation as soon as building conditions permit.
8. This Contractor shall be held solely responsible for coordinating proper size and location of hangers, slots, chases, openings, etc., required for proper installation of his work and shall arrange with the proper building contractors for inserts, chases, and openings.

9. Refer to drawings and specifications of all other divisions and trades for correlating information, location and details of work, dimensions, etc. Coordinate location of all equipment. If conflicts develop Architect or Engineer's decision will govern. No additional compensation will be allowed for moving of un-coordinated, misplaced or poorly located material, equipment or work.

H. Pre-installation meetings are required as noted in this and other specification sections and are intended to help coordination efforts. Electronic Safety and Security Contractor shall schedule and convene a pre-installation meeting with all affected trades as noted in specifications and on Drawings.

I. Provide competent representative(s) on site constantly to supervise work from beginning through completion and final acceptance. So far as possible contractor shall keep same foreman and workmen throughout project duration.

J. During its progress, the work shall be subject to observation by representatives of Owner, Architect and Engineer at which times Contractor shall furnish all required information and cooperation

1.6 SAFETY

A. Comply with the requirements of Division 01 and this specification.

B. Perform work in accordance with NFPA 70E and in compliance with OSHA requirements.

C. Do not perform work on exposed live electrical equipment. If work is required (as defined by OSHA 29 CFR 1910.333) to be performed on exposed live electrical equipment an energized work permit must be must be prepared (see NFPA 70E for energized work permit requirements) and a Hazard/Risk Analysis in accordance with NFPA 70E and provide appropriate levels of personal protective equipment according to NFPA 70E.

D. Only Qualified Persons as defined by NFPA 70E shall be allowed to work on exposed live electrical equipment. Observe the safety boundaries defined in NFPA 70E.

E. Prior to performing work on exposed live electrical equipment convene a safety meeting to address safety hazards specific to the task.

F. Safety Program: the electrical contractor shall implement and document an electrical safety program in accordance with NFPA 70E and a workplace safety program that complies with the requirements OSHA and NFPA 70E.

1.7 SUBMITTALS FOR REVIEW

A. Submit according to the requirements of Division 01 and Section 28 0100.

B. Provide manufacturers installation instructions and product data for:

1. Fire-Resistant Joint Sealers.
2. Sleeves.

1.8 SUBMITTALS FOR INFORMATION

A. Submit according to requirements of Division 01 and Section - Electronic Safety and Security General Requirements.

B. Submit written requests for System Interruptions and Outages as specified herein.

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

1.9 SUBMITTALS FOR CLOSEOUT

A. Submit according to requirements of Division 01 and Section 28 0100.

B. Include product information and installation details with O & M manuals for fire resistant joint sealers and fire resistant sleeves.

PART 2 PRODUCTS

2.1 **HANGERS AND SUPPORTS**

A. Anchors and Fasteners:
   1. Manufacturers
      a. RACO.
      b. Appelton
      c. Caddy
      d. B-Line
      e. Substitutions: Under provisions of Division 01 and Section - Electrical General Requirements.
   2. Concrete Structural Elements: Use precast insert system, expansion anchors, powder actuated anchors and preset inserts.
   3. Steel Structural Elements: Use beam clamps, spring steel clips, steel ramset fasteners, and welded fasteners.
   4. Concrete Surfaces: Use self-drilling anchors and expansion anchors.
   5. Hollow Masonry and Gypsum Board Partitions: Use toggle bolts and hollow wall fasteners.
   6. Solid Masonry Walls: Use expansion anchors and preset inserts.
   7. Sheet Metal: Use sheet metal screws.
   8. Wood Elements: Use wood screws.

B. Steel Channel:
   1. Manufacturers:
      a. B-Line Systems, Inc.
      b. Unistrut ®.
      c. Substitutions: Under provisions of Division 01 and Section - Electrical General Requirements.
   2. Description:
      a. Hot dip galvanized where located outdoors and in wet/damp locations.
      b. Painted steel indoors in dry locations.
      c. Paint cut ends of channel in damp locations.
      d. Stainless steel or nonmetallic channel as shown on plans.

C. Powder Activated Anchors: Remington. Substitutions: Under provisions of Division 01 and Section - Electrical General Requirements.

D. Spring Steel Clips:
   1. Caddy
   2. Steel City
   3. Substitutions: Under provisions of Division 01 and Section - Electrical General Requirements

E. Miscellaneous Metals:
   1. Steel plates, shapes, bars, and bar grating: ASTM A 36.
   2. Cold-Formed Steel Tubing: ASTM A 500.

3. Hot-Rolled Steel Tubing: ASTM A 501.
4. Steel Pipe: ASTM A 53, Schedule 40, welded.
5. Nonshrink, Nonmetallic Grout: Premixed, factory-packed, nonstaining, noncorrosive, nongaseous grout, recommended for interior and exterior applications.
6. Fasteners: Zinc-coated, type, grade, and class as required.

F. Miscellaneous Lumber:

1. 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 that 19 percent.
2. Construction Panels: Plywood backboards; APA A-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less than 3/4 inches.

2.2 JOINT SEALERS

A. General: Joint sealers, joint fill material, and other related materials compatible with each other and with joint substrates under conditions of service and application.

B. Colors: As selected by the Project engineer from manufacturer's standard colors.

C. Provide fire resistant joint sealers as specified in Division 07.

1. Use the following paragraph only if the Architect does not have products specified in division 07.

D. Fire-Resistant Joint Sealers: One-part or two-part, foamed-in-place, sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes, ducts and through penetrations through fire-rated walls, ceilings, roofs and floors. Sealants and accessories shall have required fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

2.3 SLEEVES

A. Sleeves for Raceways and Cables

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized Steel.
2. Rectangular Sleeves: Galvanized Sheet Steel. 16 Gauge for less than 50 square inches and not side longer than 16 inches. 8 gauge for greater than 16 inches or one side more than 16 inches.

B. Sleeve Seals

1. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
2. 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. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.
   e. Link Seal.
3. Sealing Elements: EPDM or NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
4. Pressure Plates: Carbon steel. Include two for each sealing element.
5. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element
6. Provide fire rated seals as required. See Division 07.

2.4 **CONCRETE**

A. Switchboards, motor control centers and dry type transformers shall be mounted on 3-1/2" high concrete pads furnished by this contractor. Size pads such that pad extends 2" beyond the perimeter of the equipment installed.

B. Poles provided for mounting exterior light fixtures shall be installed on or in concrete bases provided by the electrical contractor as detailed on drawings.

C. Exterior pad-mounted transformers, generators and CT Cabinets shall be mounted on concrete pads furnished by this Contractor. Pads shall be sized as required by Utility, size of equipment being installed or as detailed on drawings. Size pads such that pad extends 6" beyond the perimeter of transformers and CT cabinets and 12" for generators.

D. Concrete shall conform to Division 03 of this specification.

PART 3 EXECUTION

3.1 **COMMON REQUIREMENTS FOR EXAMINATION PRIOR TO ELECTRONIC SAFETY AND SECURITY INSTALLATIONS**

A. Verify conditions and constructions types prior to installation.

B. Verify that surfaces that support Product(s) are ready to receive them.

C. Examine location of equipment installation for compliance with installation tolerances and other conditions affecting performance of Work

1. Prepare drawings showing proposed rearrangement of work to meet Project conditions, including changes to work specified in other Divisions. Obtain permission of Architect before proceeding.

D. Review all Drawings including architectural, mechanical, structural, civil, and electrical drawings for extent of Work.

1. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.

E. Examine Architectural drawings and elevations to verify device locations and mounting heights.

1. In finished spaces, where mounting heights are not detailed or dimensioned coordinate mounting height with Architect.
2. Do not rough-in for any wall mounted equipment without verifying mounting height with Architect unless equipment is specifically noted on Architectural Drawings.
3. Do not scale dimensions from Electrical Drawings and verify all mounting heights noted on Electrical Drawings.

F. Site Investigation

1. Prior to beginning work, exam the work site to become familiar with existing conditions which may affect the cost of the project. This includes measurements for lengths, quantities, clearances and all other field verifiable conditions.
2. No extra charges will be allowed because of failure of Contractor to become familiar with all existing conditions prior to beginning work.
3. Existing equipment, systems and installations whether or not they are not detailed on the drawings must be restored to their original condition.

3.2 **COMMON REQUIREMENTS FOR PREPARATION TO INSTALLATION**

A. Equipment Wiring preparation

1. Obtain and review shop drawings, product catalog data, etc. prior to roughing-in for electrical connections.
2. Verify dimensions and final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
3. Refer to equipment drawings and specifications in all specification Divisions for rough-in requirements.

B. Demolition and remodeling preparation.

1. Notify the Owner and Architect at least five (5) days prior to commencing demolition operations
2. Demolition Drawings are based on field observation and existing record documents. Report discrepancies to Architect before disturbing existing installation.
3. Verify existing circuiting arrangements and control apparatus and wiring.
4. Verify that abandoned wiring and equipment serve only abandoned facilities.
5. Review existing equipment and materials with the Owner, schedule or indicate equipment to be salvaged for re-use and equipment to be salvaged and turned over to the Owner.
6. Beginning of demolition means Contractor accepts existing conditions.
7. Extension of existing circuits and or systems: Prior to connecting any new Work to existing circuits or systems Contractor shall provide field measurements and surveys required to ensure adequate capacity is available for new connections.

C. Hangers and Supports preparation

1. Coordinate the installation of required supporting devices, inserts and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed. Strength of construction shall not be impaired.
2. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations. Strength of construction shall not be impaired.
3. Provide plywood backboards shall be primed and painted with (2) coats of Gray enamel prior to mounting any equipment, wiring, etc

3.3 COMMON INSTALLATION REQUIRMENTS FOR ELECTRICAL WORK

A. Description Of Wiring Methods:

1. All wiring shall be installed in accordance with applicable codes.

B. Install products in accordance with NECA 1 and manufacturer's instructions.

C. Install work in locations shown on drawings, unless prevented by Project conditions. Refer to architectural drawings for exact devices locations.

D. Conform to arrangements indicated by Contract Documents, recognizing that the Work is shown only in diagrammatic form.

E. Install systems, materials and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

F. Install materials and equipment giving right-of-way priority to systems required to be installed at a specified slope.

G. Core drilling of concrete is required, where possible, in lieu of hammer drilling. Hammer drilling is generally to be limited to small holes for anchors.

H. Hangers and Supports

1. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
2. Do not fasten supports to pipes, ducts, mechanical equipment and conduit. Do not drill or cut structural members.
3. Fabricate supports from structural steel or formed steel members. Rigidly weld members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
4. Install surface-mounted cabinets, disconnects, contactors, starters and panelboards with minimum of four anchors.
5. In wet and damp locations use steel channel supports to stand cabinets, disconnects, contactors, starters and panel boards approximately one inch off wall.

I. Floor, Wall And Ceiling Penetrations

1. Effectively seal penetrations in exterior walls, roofs, and rated interior walls in accordance with Division 07.
2. Examine substrates, areas, and conditions, for compliance with requirements for installation tolerances and other conditions affecting installation and application of joint sealers and access door units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3. Conduits and cables passing through floors, walls, and ceilings at the following locations shall be sealed for the purpose of sound, heat, smoke and / or moisture control.
   a. Acoustically rated walls.
   b. Fire and / or smoke resistant walls and floors.
   c. All electrical rooms.
   d. All mechanical rooms.
   e. Penthouse.
   f. All exterior walls.
   g. All vertical and horizontal shafts.
   h. All walls around janitor rooms, receiving rooms, and other facility maintenance and management rooms.
   i. Food service areas.
4. Where conduits and raceways pass through interior walls and ceilings (not requiring water proofing) provide suitable sealing material complying with Division 07 for the wall construction; examples:
   a. Plaster for plaster walls.
   b. Joint compound for gypsum board walls.
   c. Mortar for masonry block and brick walls.
   d. Grout for concrete walls.
5. Place sealing material around each conduit and raceway for the full thickness of the wall.
6. Where conduits and raceways pass through exterior walls and ceilings below grade, provide installation to meet the details noted on the Drawings.
7. Where interior walls require waterproof conduit and raceway seals, provide silicone sealant generally installed as specified above for exterior walls.
8. Where conduits and raceways pass through exterior walls above grade, provide matching wall material inside (see examples above) and provide waterproof seal of silicone sealant or other approved sealant on outside.
9. At the nearest point of access to wires (inside conduit or raceway) passing through exterior walls and roof; provide "Ductseal" between wires and conduit or raceway as a wind barrier.
10. Where cables pass through walls, ceilings and floors, generally use same sealing method as for conduits.
11. "Ductseal" type material is generally not acceptable except as noted above.
12. Utilize fire rated cabling pathways where cabling must be routed through fire-rated floor and wall assemblies.

J. Roof Penetrations
   1. Electrical Contractor shall be responsible for providing roof seals for each raceway, mast, tower leg, guy wire, etc., which pass through roof, rest on roof or attach to roof. Avoid roof penetrations where possible. This work shall be performed by the Roofing Contractor. Electrical Contractor shall coordinate work as needed.

K. Cutting, Patching, and Finishing

1. General: Perform cutting, patching and finishing in accordance with Division 01.
   a. Cut, remove, and legally dispose of material including but not limited to construction material, and other indicated material made obsolete by the new work.

   b. Protect the structure, furnishings, finishes, and adjacent materials and installations not indicated or scheduled to be cut or removed.

   c. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt into adjacent areas.

   d. The Contractor shall not endanger the stability of the structure by cutting, excavation or otherwise.

   e. Do not cut or alter work of any other trade without trade and Architect / Engineer's consent.

2. Perform cutting, patching and finishing of walls, floors, ceilings, roofs required to:
   a. Uncover work to provide for installation of new or ill-timed work.

   b. Remove and replace defective work.

   c. Remove samples of installed work as specified for testing.

3. Upon written instructions from the Architect / Engineer, uncover and restore work to provide for Engineer's observation of concealed work.
4. Should any cutting be required for proper installation of electrical work because of failure to give the General Contractor the proper information at the time required, such cutting shall be done at the Electrical Contractors expense.

L. Equipment wiring installation
1. Provide all necessary boxes, raceways, and wiring required to make equipment and systems complete and operable.
2. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings.
3. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components.
4. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
5. Make electrical connections in accordance with equipment manufacturer's instructions.
6. Make conduit connections to equipment using flexible metal conduit. Use liquidtight flexible metal conduit with watertight connectors in damp or wet locations.
7. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
8. Provide suitable receptacle outlet to accommodate connection with attachment plug.
9. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
10. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
11. Install terminal block jumpers to complete equipment wiring requirements.
12. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

3.4 DEMOLITION AND REMODELING

A. General Demolition:
1. Remove, relocate, and extend existing installations to accommodate new construction.

2. Where indicated or required, remove existing Electronic Safety and Security systems in walls, floors, and ceilings scheduled for removal.
3. Where abandoned wiring serves equipment and / or facilities not indicated to be removed Contractor shall extend and / or reroute wiring to maintain service to the equipment that shall remain.
4. Repair adjacent construction and finishes damaged during demolition and extension work.
5. Maintain access to existing electrical installations which remain active. Modify installation or provide access door unit as appropriate.

B. Raceway and Box Demolition:

1. Remove all abandoned conduit, unless indicated to remain for re-use or future work, including abandoned conduit exposed during demolition and located above accessible ceilings.
2. Cut concealed abandoned conduit flush with walls and floors that are indicated to remain.
3. Remove abandoned boxes if conduit servicing them is removed.
4. Provide appropriate blank cover for abandoned boxes which are not removed.
5. Disconnect and remove abandoned panelboards and distribution equipment as indicated.

C. Conductor and Cabling Demolition:

1. Remove all abandoned conductors and cabling in their entirety.

D. Equipment Demolition:

1. Where indicated or required, remove all luminaires, stems, brackets, hangers, supports, etc.
2. Remove, demount, and disconnect existing electrical materials and equipment indicated to be salvaged, and deliver same to the location designated for storage. Leave in good condition and store in orderly manner.
3. Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

E. Maintain existing systems in service until new systems are complete and ready for use.

1. Disable existing systems only to make switchovers and connections.
2. Notify Architect, Construction Manager, and Owner and obtain permission before partially or completely disabling systems.
3. Minimize outage duration and coordinate time with Owner at his convenience.
4. Make temporary connections to maintain service, feeders and branch circuits when outage time exceeds 8 hours or more.

3.5 ELECTRIC UTILITY SERVICE

A. In addition to his own investigations, the Contractor is encouraged to call the following marking services prior to digging for any underground work:

1. Minnesota - 1-800-252-1166 (Gopher one call)

3.6 INTERRUPTIONS, AND OUTAGES

A. Provide temporary wiring, connections, and protection as required to maintain all existing systems to remain in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

B. Owner approval is required prior to electric service outages and shall be scheduled at the convenience of the Owner.

1. A written request must be submitted to the Owner / Architect / Engineer for approval a minimum of 15 days prior to outage.
2. Cancellation of the planned interruption by the Owner for any reason, at any time up to 24 hours before planned interruption shall bear no additional cost to the Owner.

C. Minimize outage time and provide manpower such that work can be carried out at multiple locations if required.

D. Outages may require the Contractor to work at other than regular normal working hours. No extra compensation will be allowed for such times.

3.7 EQUIPMENT AND DEVICE MOUNTING HEIGHTS

A. Coordinate final mounting heights as directed under Part 3 paragraph “Preparation”.

B. Interior mounting heights indicated on drawings are from finished floors (interior) or final grade (exterior). Mounting heights for items indicated on exterior walls are from the interior finished floor below.

C. Mounting heights indicated are to the top of the device plate unless noted otherwise. Mounting heights are nominal and shall be adjusted to fit block joints.

D. Typical mounting heights are detailed on the Drawings.

E. Handicapped counter and lavatory locations: meet ADA requirements for receptacle and switch locations and elevations.

F. Contractor shall verify mounting heights of all outlets to assure installation above top of radiation covers, mirrors, counters, vanity, cabinets, and any other obstruction that may alter indicated mounting heights. ADA accessible controls must be mounted at 48”.

3.8 COMMON REQUIREMENTS FOR OWNER INSTRUCTION AND DEMONSTRATION

A. Furnish, without additional expense to the Owner, the services of competent instructors, who will give full instructions in the care, adjustment and operation of all parts of the electronic safety and security equipment to the Owner's employees who are to have charge of the equipment. Including but not limited to the following:

1. Demonstrate the proper operation of systems per the operational and function requirements of the Contract Documents and as outlined in any sequence of operation.
2. Instruct personnel, in all phases of operation, location of components and use of all systems.
3. Review manufacturer Warranty information for all equipment included in the manual.

B. Number of hours of instruction shall be specified in other sections of this specification.

C. An operating and maintenance manual shall be made available to the Owner's operating personnel during the instruction and left with the Owner upon completion of the instruction.

D. Owner instruction / demonstration shall be provided as noted below and as noted in specification sections (see individual specification section for additional requirements):

1. Identification for Electrical Systems - review naming conventions, color schemes, warning labels, posted operating instructions, bolted connection labels, etc.
2. Fire Alarm and Detection System - review fire alarm drill procedures, monitoring company requirements, service agreements, other information required in specification section.

E. Documentation: Upon completion of Owner Instruction and Demonstration provide a certificate signed and dated by the attendees indicating information covered, amount of instruction / demonstration time provided, and applicable specification sections. Provide certificate for all Owner Instruction and Demonstration sessions. Include copy with O & M Manual. A sample certificate is attached for reference.

3.9 FIELD QUALITY CONTROL

A. So far as possible contractor shall keep same foreman and workmen throughout project duration. Keep enough workmen on job to insure keeping up with or ahead of other trades so that no delays occur.

B. Delivery, Storage, and Handling

1. Deliver, store, protect and handle products on site under provisions of Division 01 according to manufacturer’s recommendations and as specified herein.
2. This Contractor shall make provisions for delivery and safe storage of materials.
3. Accept Products on site. Inspect for damage
4. Protect Products from corrosion and entrance of debris. Provide appropriate covering. During construction, it shall be the responsibility of this Contractor to protect the surface of equipment and material furnished.
5. See individual specifications sections for specific delivery, storage, handling and protection requirements.

3.10 **CLEAN-UP, KEY CONTROL, AND PAINTING**

A. Remove all packing materials, rubbish, debris, etc. from the site each day.

B. String all furnished keys on split metal key ring and turn same over to Owner at project completion.

END OF SECTION

SECTION 28 31 13 - FIRE ALARM AND DETECTION SYSTEMS

PART 1 GENERAL

1.1 **SECTION INCLUDES**

A. Fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.

B. Furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.

1.2 **RELATED SECTIONS**

A. Drawings, addenda and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification Sections, apply to this and all other sections of Division 26, 27, 28.

B. Division 07 (Section 07 8400) - Firestopping.

C. Division 08 - Door Hardware.

D. Division 21 - Sprinkler System

E. Division 25 - Automatic Temperature Controls.

F. Section 26 0100 - Operation and Maintenance of Electrical Systems

G. Section 26 0500 - Common Work Results for Electrical

H. Section 26 0519 - Low Voltage Electrical Power Conductors and Cables

I. Section 26 0533 - Raceway and Boxes for Electrical Systems

J. Section 26 0553 - Identification for Electrical Systems

K. Section 26 0813 - Testing Electrical Systems

1.3 **REFERENCES**

A. UL 1424 - Cables for Power-Limited Fire-Alarm Circuits.

B. UL 2196 - Tests for Fire Resistive Cables.

1.4 **DEFINITIONS**

A. Qualified Service Personnel / Representative: Personnel qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be include, individuals with the following qualifications:

1. Factory trained and certified.
2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
3. International Municipal Signal Association (IMSA) fire alarm certified.
4. Certified by a state or local authority.
5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.
6. Personnel licensed or certified by state or local authority.

1.5 **SCOPE OF WORK**

A. Work covered by this section includes the furnishing of labor, equipment, and materials for installation of a complete and operational fire alarm and detection system as indicated on the drawings and specifications.

1.6 REGULATORY REQUIREMENTS

A. The system and all associated operations shall be in accordance with the following Codes:

1. International Building Code, IBC
2. International Fire Code, IFC

3. State of Minnesota Fire Codes and Building Codes.
4. NFPA 72, National Fire Alarm Code
5. NFPA 70, National Electrical Code
6. NFPA 101, Life Safety Code
7. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems
8. Other applicable NFPA standards
9. Local Jurisdictional Adopted Codes and Standards
10. ADA Accessibility Guidelines.

1.7 QUALITY ASSURANCE

A. Manufacturer: Company specializing in smoke detection, fire, and mass notification alarm systems with five years experience.

B. The Manufacturer shall be a nationally recognized company specializing in fire alarm and detection systems. This organization shall employ factory trained and NICET certified technicians, and shall maintain a service organization within 100 miles of this project location. The Manufacturer and service organization shall have a minimum of 10 years experience in the fire protective signaling systems industry.

C. System Integrator: Company specializing in smoke detection, fire, and mass notification alarm systems with five years experience and that have personnel who possess a full knowledge and understanding of systems used for fire alarm and that have factory-trained personnel to perform system design installation, testing, training, and maintenance.

D. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems.

E. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.

1.8 MAINTENANCE SERVICE

A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months, using factory-authorized service representatives.

B. Basic Services: Systematic, routine maintenance visits on a twice annual basis at times scheduled with the Owner. In addition, respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.

C. Occupancy Adjustments (Included under Basic Services): When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

D. Additional Services: Perform services within the above 12-month period not classified as routine maintenance or as warranty work when authorized in writing. Compensation for additional services must be agreed upon in writing prior to performing services.

E. Renewal of Maintenance Service Contract: No later than 60 days prior to the expiration of the maintenance services contract, deliver to the Owner a proposal to provide contract maintenance and repair services for an additional one-year term. Owner will be under no obligation to accept maintenance service contract renewal proposal.

1.9 SUBMITTALS FOR REVIEW

A. Submit the following according to the requirements of Division 01 and Section - Electrical General Requirements.

B. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.

C. Wiring diagrams from manufacturer.

D. Shop drawings showing system details including location of FACP, all devices, circuiting, device wiring details, and details of graphic annunciator (if applicable).

E. System Power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.

F. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, NAC, relay, Sensor, and auxiliary control circuits.

G. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.

1.10 SUBMITTALS FOR INFORMATION

A. Submit the following according to the requirements of Division 01 and Section - Electrical General Requirements

B. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions if required to make clarifications or revisions to obtain approval.

1.11 SUBMITTALS FOR CLOSEOUT

A. Submit the following according to the requirements of Division 01 and Section 26 0100.

B. Operation and Maintenance Manuals:

1. In addition to information required by section “Operation and Maintenance of Electrical Systems”, provide a Fire Alarm System Record of Completion in accordance with NFPA 72. Submit on form similar or identical to Figure 4.5.2.1 from NFPA 72.
2. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.
3. Operating instructions for FACP.
4. Record of field tests of system.

C. Project record drawings. Note revisions to approved shop drawings.

PART 2 PRODUCTS

2.1 FIRE ALARM CONTROL PANEL (FACP)

A. General: Comply with UL 864, "Control Units for Fire-Protective Signaling Systems."

B. The following FACP hardware shall be provided:

1. Power Limited base panel with beige cabinet and door, 120 VAC input power.
2. 2,500 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
3. 2,000 points of Network Annunciation at FACP Display when applied as a Network Node
4. 2000 points of annunciation where one (1) point of annunciation equals:
   a. 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.
   b. 1 LED on panel or 1 switch on panel.
5. From all battery charging circuits in the system provide battery voltage and ammeter readouts on the FACP LCD Display.
6. One Auxiliary electronically resettable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
7. One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.

8. Three (3) Class B Addressable Notification Appliance Signaling Line Circuits (SLCs).
    a. Each Addressable Notification Appliance SLC shall be rated at 3A and capable of supporting up to 63 Notification Appliances per channel.

    b. Wiring shall be 18 AWG to 12 AWG unshielded twisted pair wire. Systems that require shielded wire for Notification Appliances shall not be accepted.

    c. A constant voltage under both primary and secondary power conditions shall be maintained at the notification appliance field wiring terminal connections in the FACP to ensure the voltage drop on the circuit is consistent under both primary and secondary power conditions.

    d. For systems that do not provide a constant voltage source at the FACP notification appliance field wiring terminal connections, the fire alarm contractor shall:

        1) Provide separate point-to-point voltage drop calculations for all notification appliances under worst case secondary power specifications, and

        2) Perform a complete functional test of all notification appliances under worst case secondary power conditions.

9. Three (3) Class B or A (Style Y/Z) Notification Appliance Circuits (NAC; rated 3A@24VDC, resistive).
10. Where required provide Intelligent Remote Battery Charger for charging up to 110Ah batteries.
11. Power Supplies with three (3) Class B integral Intelligent Addressable Notification Appliance Signaling Line Circuits (SLCs) for system expansion.
    a. Each Addressable Notification Appliance SLC shall be rated at 3A and capable of supporting up to 63 Notification Appliances per channel.

    b. Wiring shall be 18 AWG to 12 AWG unshielded twisted pair wire. Systems that require shielded wire for Notification Appliances shall not be accepted.

    c. A constant voltage under both primary and secondary power conditions shall be maintained at the notification appliance field wiring terminal connections in the FACP to ensure the voltage drop on the circuit is consistent under both primary and secondary power conditions.

    d. For systems that do not provide a constant voltage source at the FACP notification appliance field wiring terminal connections, the fire alarm contractor shall:

        1) Provide separate point-to-point voltage drop calculations for all notification appliances under worst case secondary power specifications, and

        2) Perform a complete functional test of all notification appliances under worst case secondary power conditions.

12. Power Supplies with integral intelligent Notification Appliance Circuit Class B for system expansion.
13. Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.
14. The FACP shall support up to (5) RS-232-C ports and one service port. All (5) RS-232 Ports shall be capable of two-way communications.

15. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
16. Programmable DACT for either Common Event Reporting or per Point Reporting.
17. Fire Panel Internet Interface to provide supplemental notification and remote user access to the FACP using Ethernet and TCP/IP communications protocol compatible with IEEE Standard 802.3.

C. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.

D. Alphanumeric Display and System Controls: Panel shall include an 854 character, expanded content multi-line QVGA LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.

1. The system shall include the necessary hardware to provide expanded content, multi-line, operator interface displays as indicated on the drawings and specifications. The expanded content multi-line displays shall be Quarter-VGA (QVGA) or larger and be capable of supporting a minimum of 854 standard ASCII characters to minimize or eliminate the levels of navigation required for access to information when responding to critical emergencies and abnormal system conditions. The QVGA operator interface shall provide operator prompts and six context sensitive soft-keys for intuitive operation.
2. Activity display choices for shall be provided for:
    a. First 8 Events.
    b. First 5 Events and Most Recent Event (with first and most recent event time and date stamps).
    c. First Event and Most Recent Event (with first and most recent event time and date stamps).
    d. Scrollable List Display displays a scrollable list of active points for the event category (alarm, priority 2, supervisory, or trouble) selected. The position in this list will be the last acknowledged point (not flashing) at the top followed by the next 7 unacknowledged points (flashing).
    e. General Event Status (alarm, priority 2, supervisory, or trouble in system)
    f. Site Plan
    g. Equal or hierarchal priority assignment. In systems with two or more operator interfaces, each operator interface shall be programmable to allow multiple operator interfaces to have equal operation priority or to allow hierarchal priority control to be assigned to individual operator interfaces (locations).
    h. Up to 50 custom point detail messages for providing additional point specific information in detailed point status screens.
    i. Bitmap file import for operator interface display of site plan and background watermark images.

E. Distributed Module Operation: FACP shall be capable of allowing remote location of the following modules; interface of such modules shall be through a Style 4 (Class B) supervised serial communications channel (SLC):

1. Addressable Signaling Line Circuits
2. Initiating Device Circuits
3. Notification Appliance Circuits
4. Auxiliary Control Circuits
5. Graphic Annunciator LED/Switch Control Modules

a. In systems with two or more Annunciators and/or Command Centers, each Annunciator/Command Center shall be programmable to allow multiple Annunciators/Command Centers to have equal operation priority or to allow hierarchal priority control to be assigned to individual Annunciator/Command Center locations.

6. Amplifiers, voice and telephone control circuits

F. Voice Alarm: Provide an emergency communication system, integral with the FACP, including voice alarm system components, microphones, amplifiers, and tone generators. Features include:

1. Amplifiers comply with UL 1711, "Amplifiers for Fire Protective Signaling Systems." Amplifiers shall provide an onboard local mode temporal coded horn tone as a default backup tone. Test switches on the amplifier shall be provided to test and observe amplifier backup switchover. Each amplifier shall communicate to the host panel amplifier and NAC circuit voltage and current levels for display on the user interface. Each amplifier shall be capable of performing constant supervision for non-alarm audio functions such as background music and general paging.
2. All announcements are made over dedicated, supervised communication lines. All risers shall support Class B wiring for each audio channel.
3. Emergency voice communication audio controller module shall provide up to 32 minutes of message memory for digitally stored messages. Provide supervised connections for master microphone and up to 5 remote microphones.
4. Status annunciator indicating the status of the various voice alarm speaker zones and the status of fire fighter telephone two-way communication zones.
5. When required, Redundant Voice Command Centers shall be capable of generating voice paging from more than one node in a network audio system.

G. Evacuation System - Non-Alarm Audio

1. The fire alarm control panel shall provide non-alarm audio from an owner supplied paging and/or music source over the fire alarm evacuation speakers. This feature shall be an integral part of the fire alarm system, and shall use some or all of the audio components from the fire alarm evacuation system.
2. The fire alarm system and the non-alarm audio operation shall comply with NFPA 72 requirements for non-emergency purposes at a fire command center that is not constantly attended by a trained operator.
3. All fire alarm system hardware and software shall be U.L. listed for non-alarm audio use. The fire alarm system shall supervise for system hardware and field wiring faults while playing non-alarm audio over the evacuation speakers. Any hardware failure or speaker circuit fault detected when the system is playing non-alarm audio shall report a trouble on the fire alarm control panel. All audio components used for both the non-alarm audio and the fire alarm evacuation system shall be manufactured by the same supplier.
4. The non-alarm audio shall have two dedicated audio inputs to the fire alarm control panel. Terminal strip connections and an industry standard RCA receptacle shall be provided at the fire alarm control panel for terminating the owners audio source. The fire alarm input shall be 600-Ohm impedance. The inputs on the fire alarm control panel shall be electrically isolated via an isolation transformer.
5. The fire alarm control panel shall accept industry standard "line level audio input" from the owner's non-alarm audio source. The fire alarm system hardware and software shall distribute the audio over the fire alarm evacuation speakers. The selection of which speaker zones to distribute the non-alarm audio to the building occupants shall be coordinated with the owners representative.
6. The fire alarm control panel shall be able to make audio input level adjustments from the owners non-alarm audio source. This adjustment will match the non-alarm audio source to the fire alarm input. After the audio levels are adjusted, the owner shall control the volume level from the non-alarm audio source.
7. The fire alarm system will provide "buttons" have the capability to provide operator "buttons" that will adjust the volume level of pre-assigned non-alarm audio zones. The volume level of non-alarm audio that is being broadcast to any audio zone will also be individually adjustable by time of day via a pre-specified schedule.

8. The non-alarm audio shall be the lowest priory audio on the fire alarm system. The non-alarm audio shall not interfere with any of the fire alarm emergency signals that may include live voice, pre-recorded emergency voice messages, or any alert tones. Switches shall be located on the fire alarm control panel to turn on or off the non-alarm audio system feature. The fire alarm control panel shall have LED lamps to indicate the ON vs. OFF status of the non-alarm audio feature. Speaker circuits that are actively broadcasting non-alarm audio will also be indicated by LEDs.
9. The non-alarm audio shall be synchronized throughout the fire alarm life safety system amplifiers and speaker circuits. Any remote amplifier panels located on the fire alarm system network shall also be synchronized. The system shall be capable of accepting a system-wide non-alarm audio input at the main fire alarm control or another local non-alarm audio input at a remote amplifier panel to serve only the areas served by that remote panel.
10. Multiple non-alarm audio sources must be accessible by the fire alarm non-alarm audio system. Each separate non-alarm audio source will have the ability to be broadcast into a distinct fire zone, depending on occupant preference. Any system restricted to a limited number of non-audio sources will not be accepted. The system must have the capability of broadcasting an unlimited number of non-alarm sources, except as determined by the number of individual fire zones served by the fire alarm system.
11. Non-alarm audio shall be automatically turned off in the event of primary power failure to the fire alarm control panel or any of the remote amplifier panels controlled by the main fire alarm control panel.

2.2 EMERGENCY POWER SUPPLY

A. General: Components include battery, charger, and an automatic transfer switch.

B. Battery: Sealed lead-acid or nickel cadmium type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for time period specified in part 1 above. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm notification devices in alarm mode for the time period noted in part 1 above.

2.3 REMOTE LCD ANNUNCIATOR

A. Provide where required a remote LCD Annunciator with the same "look and feel" as the FACP operator interface. The Remote LCD Annunciator shall use the same Primary Acknowledge, Silence, and Reset Keys, Status LEDs and LCD Display as the FACP.

B. Annunciator shall have super-twist LCD display with two lines of 40 characters each. Annunciator shall be provided with four (4) programmable control switches and associated LEDs.

C. Under normal conditions the LCD shall display a "SYSTEM IS NORMAL" message and the current time and date.

D. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.

E. The LCD shall display the following information relative to the abnormal condition of a point in the system:

1. 40 character custom location label.
2. Type of device (e.g., smoke, pull station, waterflow).
3. Point status (e.g., alarm, trouble).

F. Operator keys shall be key switch enabled to prevent unauthorized use. The key shall only be removable in the disabled position. Acknowledge, Silence and Reset operation shall be the same as the FACP.

2.4 STANDARD ALARM NOTIFICATION APPLIANCES

A. Visible/Only: Strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. V/O appliances shall be

provided with different minimum flash intensities of 15cd, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.

B. Audible/Visible: Combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Provide a label inside the strobe lens to indicate the listed candela rating of the specific strobe. The horn shall have a minimum sound pressure level of 85 dBA @ 24VDC. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings.

C. Notification Appliance Circuit provides synchronization of strobes at a rate of 1Hz and operates horns with a Temporal Code Pattern operation. The circuit shall provide the capability to silence the audible signals, while the strobes continue to flash, over a single pair of wires. The capability to synchronize multiple notification appliance circuits shall be provided.

D. Alarm lights, horns, speakers shall have white lettered FIRE on red lens.

E. Alarm lights, horns, speakers shall have red lettered FIRE on white lens.

F. Accessories: The contractor shall furnish the necessary accessories.

2.5 EMERGENCY CONTROL DEVICES

A. Magnetic Door Holders

1. Description: Units shall be listed to UL 228. Units are equipped for wall or floor mounting as indicated and are complete with matching door plate. Unit shall operate from a 120VAC, a 24VAC or a 24VDC source, and develop a minimum of 25 lbs. holding force.
2. Material and Finish: Match door hardware.

2.6 CONDUIT AND BOXES

A. Conduit shall be as specified in Section - Raceways and Boxes for Electrical Systems.

B. Conduit shall have red pigmentation.

C. ¾” diameter minimum.

2.7 DEVICE GUARDS

A. Welded wire mesh, matched to the size and shape of the manual station, detector, indicating device. Painted to match the device.

2.8 CONDUIT AND BOXES

A. Conduit shall be as specified in Section - Raceways and Boxes for Electrical Systems.

B. Conduit shall have red pigmentation.

C. ¾” diameter minimum.

2.9 FIRE ALARM WIRE

A. Provide wiring as recommended by manufacturer and by system vendor in compliance with local codes.

B. Conductors shall comply with NFPA 70 Article 760. Conductors shall be stranded copper.

C. Number and size of conductors will be as specified by the manufacturer (not less than 18 AWG for SLCs and IDCs, and 14 AWG for NACs). All wires shall be color coded as suggested by the Manufacturer.

D. Power Limited Circuits: 300-volt minimum rated.

E. Non-Power Limited Circuits: 600-volt minimum rated.

F. RHW and RHH type cable shall not be acceptable.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field measurements are as shown on Drawings and instructed by manufacturer.

C. Verify that required utilities are available, in proper location, and ready for use.

3.2 PREPARATION

A. Notify the Authority Having Jurisdiction, prior to installation and / or alteration of existing system.

B. Review manufacturer's approved shop drawings prior to beginning installation.

C. Coordinate mounting heights with Architect, manufacturer's installation instructions, and applicable code requirements.

D. Coordinate route of any required surface mounted conduit and / or raceway located at a public or finished space with Architect prior to rough-in.

E. Coordinate detector locations with luminaires and air supply and return grilles.

F. Coordinate location of duct mounted detectors with mechanical contractor.

G. Elevator shaft and equipment room, coordinate temperature rating and location of heat detectors with sprinkler head rating and location.

3.3 INSTALLATION

A. Install system components and all associated devices in accordance with manufacturer's approved shop drawings, applicable Building Codes, Fire Codes, and NFPA Standards. All devices shall be mounted and installed to comply with NFPA 72 and to meet ADA requirements.

B. Utilize manufacturer's approved shop drawings during installation.

C. General Requirements for Equipment Installation:

1. Install similar devices at the same height unless noted otherwise.
2. Smoke and Heat Detector Spacing:
   a. Comply with NFPA 72 "Initiating Devices" chapter for spacing of smoke and heat detectors.
   b. Locate detectors 3-feet away from air-supply diffusers and return air openings minimum.
   c. Locate detectors 1-foot away from light fixtures minimum.
3. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes to extend the full width of the duct.
4. Audible Alarm Indicating Devices: Install not less than 6-inches below ceiling.
5. Visible Alarm Indicating Devices: Install bottom of lens 80-inches above finished floor minimum, and at least 6-inches below ceiling.
6. Annunciator: Install top of panel not more than 72-inches above finished floor.
7. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.

D. Wiring and Conduit:

1. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.
2. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits.
3. Paint fire alarm system junction boxes and covers red.
4. Conduit shall have factory applied red pigmentation.
5. All wiring under this Section shall be in enclosed raceway.
6. Mount outlet box for electric door holder to withstand 80 pounds pulling force.

7. Make conduit and wiring connections to all devices required for complete system operation as noted on drawings and specified herein.

E. Mount end-of-line device in box with last device or separate box adjacent to last device for Class "B" supervision.

F. Ethernet Drop: A standard RJ-45 Ethernet connection to the owner’s Ethernet network shall be provided at each fire alarm control panel as part of the contract.

G. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction (AH and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC).

H. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.

I. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red..

3.4 FIELD QUALITY CONTROL

A. Utilize manufacturer’s approved shop drawings during installation.

B. Manufacturer's Field Services: Provide services of a factory-authorized qualified service representative to supervise the field assembly and connection of components and the pretesting, and final testing.

C. Performance Verification Testing

1. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications.
   a. Correct deficiencies observed in pretesting.
   b. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
2. Test the system according to the procedures outlined in NFPA 72.
3. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies.
4. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

D. Acceptance Testing (By the Authority Having Jurisdiction)

1. Contractor shall schedule test.
2. Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing to be provided by the Authority Having Jurisdiction.
3. Notify Architect of any deficiencies.

3.5 OWNER INSTRUCTION AND TRAINING

A. Provide the services of a factory-authorized qualified service representative to demonstrate the system and train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 6 hours' training.
2. Provide a two 3-hour training sessions on two different days unless requested otherwise.
3. Schedule training with the Owner at least seven days in advance.
4. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.

3.6 DOCUMENTATION

A. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log.

3.7 CLEANING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean devices internally using methods and materials recommended by manufacturer.

END OF SECTION

SECTION 32 3119
DECORATIVE METAL FENCES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Decorative aluminum fences.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

A. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes.

B. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

C. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

D. ASTM D523 - Standard Test Method for Specular Gloss.

E. ASTM D714 - Standard Test Method for Evaluating Degree of Blistering of Paints.

F. ASTM D822/D822M - Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.

G. ASTM D1654 - Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.

H. ASTM D2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.

I. ASTM D2794 - Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).

J. ASTM D3359 - Standard Test Methods for Rating Adhesion by Tape Test.

K. ASTM F2408 - Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to start of work of this section; require attendance by affected installers.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit manufacturer's data sheets on each product to be used.

C. Shop Drawings:
   1. Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, gates, and schedule of components.
   2. Foundation details, concrete design mix and reinforcing schedule for anti-ram barrier system.

D. Samples: Submit two samples of fence panels, 12 inch by 12 inch in size illustrating construction and colored finish.

E. Manufacturer's Warranty.

1.06 QUALITY ASSURANCE

A. Designer Qualifications: Design decorative metal fence and its structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed at the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

C. Installer Qualifications: Experienced with type of construction involved and materials and techniques specified.

1.07 DELIVERY, STORAGE AND HANDLING

A. Store materials in a manner to ensure proper ventilation and drainage. Protect against damage, weather, vandalism and theft.

1.08 WARRANTY

A. All structural fence components (i.e. rails, pickets, and posts) shall be warranted within specified limitations, by the manufacturer for a period of 20 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding.

B. Reimbursement for labor necessary to restore or replace components that have been found to be defective under the terms of manufactures warranty shall be guaranteed for five (5) years from date of original purchase.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Decorative Metal Fences and Gates:
   1. **BASIS OF DESIGN:** Ameristar Perimeter Security, USA; Echelon II, Majestic: www.ameristarperimeter.com/#sle.
   2. Substitutions: See Section 01 6000 - Product Requirements.

2.02 FENCES

A. Fences: Complete factory-fabricated system of posts and panels, accessories, fittings, and fasteners; finished with electrodeposition coating, and having the following performance characteristics:
   1. Capable of resisting vertical load, horizontal load and infill performance requirements for fence categories defined in ASTM F2408.

B. Electro-Deposition Coating: Multistage pretreatment/wash with zinc phosphate, followed by epoxy primer and acrylic topcoat.
   1. Total Coating Thickness: 2 mils, minimum.
   2. Color: Black.
   3. Coating Performance: Comply with general requirements of ASTM F2408.
      a. Adhesion: ASTM D3359 (Method B); Class 3B with 90 percent or more of coating remaining in tested area.
      b. Corrosion Resistance: ASTM B117, ASTM D714 and ASTM D1654; 1/8 inch coating loss or medium No.8 blisters after 1,500 hours.
      c. Impact Resistance: ASTM D2794; 60 inch pounds.
      d. Weathering Resistance: ASTM D523, ASTM D822/D822M and ASTM D2244; less than 60 percent loss of gloss.

C. Aluminum: ASTM B221.
   1. Tubular Pickets, Rails and Posts: 6005-T5 alloy.
   2. Extrusions for Posts and Rails (Outer Channel): 6005-T5 alloy.
   3. Extrusions for Pickets and Rail (Inner Slide Channels): 6063-T5 alloy.

D. Fasteners: ASTM A276/A276M, Type 302 stainless steel; finished to match fence components.
   1. Tamper-proof security bolts.

2.03 ALUMINUM FENCE

A. Decorative Aluminum Fence System: Provide fence and delegated design meeting the Test Load and Coating Performance requirements of ASTM F2408 for Industrial class.
   1. Fence Panels: 3 feet, 6 inches high minimum by 8 feet long or maximum width and meet overturning.
      a. Panel Style: Three rail.

b. Posts: Aluminum extrusions; 3 inches square.
c. Rails: Extruded aluminum channels.
d. Pickets: Extruded aluminum tubes.
    1) Size: 1 inch square.
    2) Style: Flush top rail.
e. Fasteners: Manufacturer's standard stainless steel bolts, screws, and washers; factory finish fasteners to match fence.
f. Accessories: Aluminum castings, extrusions, and cold-formed strips; factory finished to match fence.
    1) Flat post cap.
g. Flexibility: Capable of following variable slope of up to 1:4.
h. Color: Manufacturer's standard, factory applied Black.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Set fence posts in accordance with the manufacturer recommended spacing.

C. When cutting rails immediately seal the exposed surfaces by:
    1. Removing metal shavings from cut area.
    2. Apply zinc-rich primer to thoroughly cover cut edge and drilled hole; allow to dry.
    3. Apply two coats of custom finish spray paint matching fence color.
    4. Failure to seal exposed surfaces in accordance with manufacturer's instructions will negate manufacturer's warranty.

3.04 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch.

B. Maximum Offset From Indicated Position: 1 inch.

3.05 CLEANING

A. Leave immediate work area neat at end of work day.

B. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.

C. Clean fence with mild household detergent and clean water rinse well.

D. Touch up scratched surfaces using materials recommended by manufacturer. Match touched-up paint color to factory-applied finish.

E. See Section 01 7419 - Construction Waste Management and Disposal, for additional requirements.

3.06 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair, or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 33 4100
SUBDRAINAGE

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2021.

B. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity; 2022.

C. ASTM D4533/D4533M - Standard Test Method for Trapezoid Tearing Strength of Geotextiles; 2015 (Reapproved 2023).

D. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles; 2015a (Reapproved 2023).

E. ASTM D4751 - Standard Test Methods for Determining Apparent Opening Size of a Geotextile; 2021a.

F. ASTM D4833/D4833M - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products; 2007 (Reapproved 2020).

1.02 SECTION INCLUDES

A. Building Perimeter drainage systems.

B. Filter aggregate and fabric and bedding.

1.03 RELATED REQUIREMENTS

A. 00 3100 - Available Porject Information: Geotechnical Report.

B. Mechanical Drawings and 22 1429 - Sump Pits: For draintile ejector pits.

C. Architectural and Structural Drawings: For draintile locations.

D. Civil and Structural Notes: For draintile excavation and backfill.

1.04 REFERENCE STANDARDS

A. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

B. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

C. ASTM D4751 - Standard Test Methods for Determining Apparent Opening Size of a Geotextile.

D. ASTM D4533/D4533M - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

E. ASTM D4833/D4833M - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.

F. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on pipe drainage products, pipe accessories, and fabric.

C. Shop Drawings: Indicate dimensions, layout of piping, high and low points of pipe inverts, gradient of slope between corners and intersections, and outlets.

D. Project Record Documents: Record location of pipe runs, connections, cleanouts and principal invert elevations.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Comply with applicable code for materials and installation of the work of this section.

2.02 PIPE MATERIALS

A. Polyvinyl Chloride Pipe: ASTM D2729; plain end, 4 inch inside diameter; with required fittings.

B. Corrugated Plastic Tubing: Flexible type; 4 inch diameter, with required fittings.

C. Use perforated pipe at subdrainage system (perforations orientated in the up direction); unperforated through sleeved walls and at lateral drain lines running under the building.

2.03 AGGREGATE AND BEDDING

A. Filter Aggregate and Bedding Material: Granular fill as indicated in Drawings and Geotechnical Report.

2.04 ACCESSORIES

A. Pipe Couplings: Solid plastic.

B. Geotextile for Filtration: Capable of allowing liquid passage while restricting solids.
   1. Type: Nonwoven.
   2. Seams: Lap.
      a. Overlap: 12 inch.
      b. Strength: 85 percent of grab, minimum, in accordance with ASTM D4632/D4632M.
      c. Limit seams perpendicular to direction of construction.
   3. Grab Strength: 300 lbf, minimum, when tested in accordance with ASTM D4632/D4632M.
   4. Permittivity: 0.5 per second, minimum, in accordance with ASTM D4491/D4491M.
   5. Apparent Opening Size: No.40, 0.016 inch, maximum, when tested in accordance with ASTM D4751.
   6. Trapezoid Tear Strength: 100 lbf, minimum, when tested in accordance with ASTM D4533/D4533M.
   7. Puncture Strength: 450 lbf, minimum, when tested in accordance with ASTM D4833/D4833M.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that excavated base is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

3.02 3.02 PREPARATION

A. Hand trim excavations to required elevations. Correct over-excavation with aggregate.

B. Remove large stones or other hard matter that could damage drainage piping or impede consistent backfilling or compaction.

3.03 INSTALLATION

A. Install and join pipe and pipe fittings in accordance with pipe manufacturer's instructions.

B. Place drainage pipe on compacted impervious fill.

C. Lay pipe to slope gradients noted on drawings; with maximum variation from true slope of 1/8 inch in 10 feet.

D. Place pipe with perforations facing up. Mechanically join pipe ends.

E. Install pipe couplings.

F. Install filter aggregate at sides, over joint covers and top of pipe. Provide top cover compacted thickness of 12 inches.

G. Place filter fabric over levelled top surface of aggregate cover prior to subsequent backfilling operations.

H. Place aggregate in maximum 6 inch lifts, consolidating each lift.

I. Refer to site Drawings and Notes for compaction requirements. Do not displace or damage pipe when compacting.

J. Connect to storm sewer system with unperforated pipe, through installed sleeves.

K. Lateral drain lines running under the building to be unperforated pipe.

L. Coordinate the Work with connection to municipal sewer utility service, and trenching.

3.04 FIELD QUALITY CONTROL

A. Section 01 4000 - Quality Requirements: Field inspection and testing.

B. Request inspection prior to and immediately after placing aggregate cover over pipe.

3.05 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation begins.

END OF SECTION 33 4100