NDSU

Richard D. Offerdahl '65 Engineering Complex

Building 167

Fargo, North Dakota

Bid Package 3
Project Specification Manual
****See also McGough Bidding Documents****

Volume 2 of 2

September 12, 2024
ZBA Project No. 23-026

Architect of Record:
Zerr Berg Architects
510 4th Avenue North
Fargo, North Dakota 58102
P: 701.280.0187

Design Architect:
BWBR
380 St. Peter Street #600
St. Paul, MN 55102
P: 651.222.2701

Construction Manager:
McGough Construction
630 1st Avenue North #4
Fargo, ND 58102
P: 701.639.6282

ZBA
ZERR·BERG

BWBR

McGough

SECTION 00 0105
CERTIFICATIONS

FOR THE:
North Dakota State University
Richard D. Offerdahl '65 Engineering Complex - Building 167
Fargo, North Dakota

ZERR BERG ARCHITECTS, INC. **PROJECT ARCHITECT**

I here by certify that this specification was prepared by me or under my direct supervision, and that I am a duly Licensed Architect under the laws of the state of North Dakota.

Tyler Brandriet DATE September 12, 2024 LICENSE NO. 2911

Tyler J. Brandriet

HEYER ENGINEERING **STRUCTURAL CONSULTANT**

I here by certify that this specification was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the state of North Dakota.

Jason Skiple DATE September 12, 2024 LICENSE NO. PE-4362

Jason Skiple

CMTA, INC. **MECHANICAL CONSULTANT**

I here by certify that this specification was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the state of North Dakota.

Cody D. Ellingson DATE September 12, 2024 LICENSE NO. PE-7115

Cody D. Ellingson

CMTA, INC. **ELECTRICAL CONSULTANT**

I here by certify that this specification was prepared by me or under my direct supervision, and that I am a duly Licensed Professional Engineer under the laws of the state of North Dakota.

Andrew Bartsch DATE September 12, 2024 LICENSE NO. PE-6525

Andrew A. Bartsch

DESIGN TEAM

FOR THE:

North Dakota State University
Richard D. Offerdahl '65 Engineering Complex - Building 167
Fargo, North Dakota

ZBA PROJECT NO. 23-026

ZERR BERG ARCHITECTS, INC. **PROJECT ARCHITECT**

510 4th Avenue North
Fargo, North Dakota 58102
Tel: 701-280-0187

BWBR ARCHITECTS, INC. **DESIGN ARCHITECT**

380 St. Peter Street, Suite 600
St. Paul, MN 55102
Tel: 720-547-5570

HEYER ENGINEERING **STRUCTURAL CONSULTANT**

1020 36th St. SW
Fargo, ND 58103
Tel: 701-280-0949

CMTA, INC. **CIVIL, MECHANICAL, AND ELECTRICAL CONSULTANT**

2201 12th Street North, Suite E
Fargo, ND 58102
Tel: 701-280-0500

END OF SECTION

SECTION 00 0110
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END OF SECTION

SECTION 21 0100 - FIRE PROTECTION GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 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.

1.02 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".

1.03 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.

1.04 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.

1.05 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.

1.06 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.

1.07 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. 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 one 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).

1.08 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. Manuals shall be 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. All sections shall be referenced with plastic tabs.

D. 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.

E. 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.

F. 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.

G. The following items shall also be included in the manuals for the Owners information: Factory start-up reports, Valve Tag list, 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.

H. Provide with the 3-ring binder hard copy manuals, and electronic copy in PDF format. The electronic copies in PDF format shall be tabbed at each section for ease of finding specific items as listed in the manual. All items as described above that are found in the 3-ring binders shall also be found in the electronic version. The PDF copy shall be labeled indicating “O&M Manual”, “Project Name” & “Contractor”.

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

1.09 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.
   2. Fire pump and or jockey pump including all components and controllers shall not be less than four (4) man hours.

1.10 MECHANICAL LIST OF CONSTRUCTION CLOSEOUT DOCUMENTS

A. This Contractor and their subcontractors should proceed immediately to fully complete the work as listed in Appendix 'A' 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 N/A where items don’t pertain.

1.11 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.

1.12 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.

1.13 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.

1.14 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.

1.15 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.

1.16 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.

1.17 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.

1.18 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.

1.19 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.

1.20 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

2.01 NOT USED

PART 3 EXECUTION

3.01 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	_____	_____	_____	_____	_____	_____
Fire Pump	_____	_____	_____	_____	_____	_____

Contractor _____

Owner Representative _____

3.02 LIST OF CONSTRUCTION CLOSEOUT DOCUMENTS:

SECTION	DOCUMENT	DATE / INITIALS	APPROVED
21 00 00	Record Drawings Fire Protection		
21 00 00	O&M Manuals Fire Protection		
21 00 00	Owners Instruction Fire Protection		
21 00 00	Provide letter/certification from state/city of acceptance		
21 00 00	Provide all equipment labels per specifications		
21 00 00	Provide wall escutcheon on all piping penetrations through all walls and floors		
21 00 00	Clean all mechanical areas of debris and wipe down all fixtures and equipment. Remove extra materials and garbage from site.		
21 00 00	Submit all factory/contractor equipment start up records		
21 00 00	Contractor to ensure that all holes, existing and new have been patched and repaired and all openings remaining around duct and pipe penetrations shall be filled, caulked, and painted to match wall per specifications.		
21 00 00	Record drawings fire protection		

END OF SECTION

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SECTION 21 0150 - FIRE PROTECTION MATERIALS & METHODS

PART 1 GENERAL

1.01 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.

1.02 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

2.01 NOT USED

PART 3 EXECUTION

3.01 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.

3.02 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.

3.03 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.

3.04 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.

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

3.06 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.

3.07 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 0500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 REFERENCE STANDARDS

A. ASME A112.18.1 - Plumbing Supply Fittings; 2018, with Errata.
B. ASME BPVC-IX - Qualification Standard for Welding, Brazing, and Fuzing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators - Welding Brazing and Fusing Qualifications; 2019.
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; 2016.
E. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; 2016.
F. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2020.
H. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2019.
I. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).
J. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2022a.
K. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).
L. AWWA C606 - Grooved and Shouldered Joints; 2015.
M. FM (AG) - FM Approval Guide; current edition.
N. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
O. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems; 2024.
P. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.03 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.

1.04 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.

1.05 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

2.01 GENERAL REQUIREMENTS

A. Sprinkler-based System:
   1. Comply with NFPA 13.
   2. See Section 21 1300.

B. Standpipe and Hose System:
   1. Comply with NFPA 14.
   2. See Section 21 1200.

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

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

2.02 ABOVE GROUND PIPING

A. Steel Pipe: ASTM A53 Schedule 40 or schedule 10 for 2 1/2 inch or larger or as indicated, black. Dry pipe systems shall be all schedule 40, galvanized.
   1. Steel Fittings: ASTM A234/A234M wrought carbon steel or alloy steel.
   2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings and ASME B16.4, threaded fittings.
   3. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A47/A47M.
   4. 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.
   5. All dry system piping fittings shall be galvanized.

2.03 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 Below Grade Exterior Walls:
   1. Zinc-coated or cast-iron pipe.
   2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.

C. Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:
   1. Galvanized steel pipe or black iron pipe with asphalt coating.
   2. Connect sleeve with floor plate except in mechanical rooms.

2.04 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.
   4. Substitutions: See Section 01 6000 - Product Requirements.

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.

2.05 PIPE HANGERS AND SUPPORTS

A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.

B. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.

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

D. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.

E. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
F. Vertical Support: Steel riser clamp.
G. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2.06 MECHANICAL COUPLINGS

A. Manufacturers:
   1. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
   2. Victaulic Company: www.victaulic.com/#sle.
   3. Substitutions: See Section 01 6000 - Product Requirements.
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

3.01 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.

3.02 INSTALLATION

A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.
B. Install standpipe piping, hangers, and supports in accordance with NFPA 14.
C. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
D. Install piping to conserve building space, to not interfere with use of space and other work.
E. Group piping whenever practical at common elevations.
F. Seal exterior wall penetrations above grade weather tight.
G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
H. 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.
I. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
J. 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.
K. Structural Considerations:
   1. Do not penetrate building structural members unless indicated.
L. Provide sleeves when penetrating floors, walls, and partitions. 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 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.
3. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.

M. 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.

N. 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.

O. 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.

3.03 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 0513 - COMMON MOTOR REQUIREMENTS FOR FIRE SUPPRESSION EQUIPMENT

<<<< UPDATE NOTES

PART 1 GENERAL

2.01 SECTION INCLUDES

A. General construction and requirements.
B. Applications.
C. Single phase electric motors.
D. Three phase electric motors.

2.02 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.
B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2004.
C. NEMA MG 1 - Motors and Generators; 2017.
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

2.03 SUBMITTALS

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

2.04 QUALITY ASSURANCE

A. Comply with NFPA 70.

2.05 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.

2.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
B. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 PRODUCTS

3.01 MANUFACTURERS

A. Baldor Electric Company/ABB Group: www.baldor.com/#sle.
B. Regal-Beloit Corporation (Century): www.centuryelectricmotor.com/#sle.
C. Substitutions: See Section 01 6000 - Product Requirements.

3.02 GENERAL CONSTRUCTION AND REQUIREMENTS

A. A. This section shall not apply to fire pump or jockey pump motors. Fire pump and jockey pump motors shall be as approved by U.L. and F.M. requirements and meet the requirements of NFPA 20. Refer to specification section 213000.
B. Nominal Efficiency:
    1. All motors 1 HP and larger, furnished separately or as part of equipment provided on this project, shall be premium efficiency type. The motor's NEMA Nominal Efficiency Rating as stamped on the motor nameplate shall meet or exceed NEMA threshold full-load nominal efficiency values for energy-efficient motors (from NEMA MG1 table 12-10).
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 1 limits for insulation class, service factor, and motor enclosure type.
D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
E. Wiring Terminations:
    1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
    2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

3.03 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. Single phase motors for pumps: Capacitor start type.

3.04 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. Pull-up Torque: Up to 350 percent of full load torque.
D. Breakdown Torque: Approximately 250 percent of full load torque.
E. 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.
F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.
G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

3.05 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. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
D. Design, Construction, Testing, and Performance: Comply with NEMA MG 1 for Design B motors.
E. Insulation System: NEMA Class B or better.
F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
H. 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 2913.
I. 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.
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.

PART 3 EXECUTION

4.01 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 21 0523 - GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.01 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.

1.02 ABBREVIATIONS AND ACRONYMS

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

1.03 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 - Qualification Standard for Welding, Brazing, and Fuzing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators - Welding Brazing and Fusing Qualifications; 2019.
E. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service; 2023.
F. AWWA C606 - Grooved and Shouldered Joints; 2015.
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; 2022, with Errata.
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.

1.04 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.

1.05 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.

1.06 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

2.01 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.

2.02 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.

2.03 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.

2.04 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.

2.05 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.

2.06 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

3.01 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.

3.02 INSTALLATION

A. Comply with specific valve installation requirements and application in the following Sections:
   1. Section 21 1300 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 0553 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

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SECTION 21 0553 - IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 REFERENCE STANDARDS

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

1.03 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

2.01 IDENTIFICATION APPLICATIONS

A. Control Panels: Nameplates.
B. Major Control Components: Nameplates.
C. Piping: Pipe markers.
D. Pumps: Nameplates.
E. Valves: Tags and ceiling tacks where above lay-in ceilings.

2.02 NAMEPLATES

A. Manufacturers:
    1. Brimar Industries, Inc: www.pipemarker.com/#sle.
    2. Seton Identification Products, a Tricor Direct Company: www.seton.com.
    3. Substitutions: See Section 01 6000 - Product Requirements.
B. Description: Laminated three-layer plastic with engraved letters.

2.03 TAGS

A. Manufacturers:
    1. Brimar Industries, Inc: www.pipemarker.com/#sle.
    2. Seton Identification Products, a Tricor Direct Company: www.seton.com.
    3. Substitutions: See Section 01 6000 - Product Requirements.
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.

2.04 PIPE MARKERS

A. Manufacturers:
    1. Brimar Industries, Inc: www.pipemarker.com/#sle.
    2. Seton Identification Products, a Tricor Company: www.seton.com.
    3. Substitutions: See Section 01 6000 - Product Requirements.
B. Color: Comply with ASME A13.1.
C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

2.05 CEILING TACKS

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

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
B. Install tags with corrosion resistant chain.
C. Stencils/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.
D. Install plastic pipe markers in accordance with manufacturer's instructions.
E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
F. 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 0784 - MECHANICAL FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Firestopping systems.

B. Firestopping of all mechanical through and membrane penetrations in fire-resistance rated and smoke-resistant assemblies , whether indicated on drawings or not .

1.02 REFERENCE STANDARDS

A. ASTM E 814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops; 2009.

B. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.

C. FM 4991 - Approval of Firestop Contractors; Factory Mutual Research Corporation; 2001.

D. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.

E. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.

F. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.03 SUBMITTALS

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

B. Closeout Documents:

1. Certificate from authority having jurisdiction indicating approval of materials used.

1.04 QUALITY ASSURANCE

A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.

1. Listing in the current-year classification or certification books of UL, FM, or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.
2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.

B. Installer Qualifications: Company specializing in performing the work of this section and:

1. Approved by Factory Mutual Research under FM Standard 4991, Approval of Firestop Contractors , or meeting any two of the following requirements:.
2. With minimum 3 years documented experience installing work of this type.
3. Able to show at least 5 satisfactorily completed projects of comparable size and type.
4. Licensed by authority having jurisdiction.

1.05 MOCK-UP

A. Install one firestopping assembly representative of each fire rating design required on project.

B. Obtain approval of authority having jurisdiction before proceeding.

C. If accepted, mock-up will represent minimum standard for the Work.

D. If accepted, mock-up may remain as part of the Work. Remove and replace mock-ups not accepted.

1.06 SCOPE / APPLICATION

A. Provide installed firestop protects that limit the spread of fire, heat, smoke, and gasses through otherwise unprotected openings in rated assemblies, including walls, partitions, floors, roof/ceilings, and similar locations. restoring the integrity of the fire rated construction to its original fire rating.

B. Provide firestop systems listed for the specific combination of fire rated construction, type of penetrating item, annular space requirements, and fire rating, and the following criteria:

1. F-Rating: Equal to or greater than the fire-resistance rating of the assembly in which the firestopping will be installed.
2. T-Rating: In habitable areas where penetrating items are exposed to potential contact with materials on fire side(s) of rated assembly, T-rating must equal its F-rating.
3. L-Rating: L-rating of 1 cfm per linear foot (5.5 cu m/h/m) maximum at ambient temperatures.
4. Wall Penetrations: Systems must be symmetrical, with the same rating from both sides of the wall.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. A/D Fire Protection Systems Inc: www.adfire.com.

B. 3M Fire Protection Products: www.3m.com/firestop.
C. Hilti, Inc: www.us.hilti.com.
D. Nelson FireStop Products: www.nelsonfirestop.com.
E. RectorSeal: www.rectorseal.com.
F. International Protective Coatings Corp.

2.02 THROUGH PENETRATION FIRESTOP SYSTEMS

A. Firestopping: Any material meeting requirements.
   1. Fire Ratings: Use any system listed by UL or tested in accordance with ASTM E 814 that has F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and that meets all other specified requirements.
   2. Fire Ratings: See Drawings for required systems and ratings.

2.03 MATERIALS

A. Firestopping Sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
B. Cast-in-Place Devices: Firestopping device for use prior to a concrete pour. Adjustable height with pull tabs, straight edge design for close placement to walls and adjacent devices.
   1. Fire Resistance: For use in 1, 2, or 3 hour fire rated systems.
C. One piece metal collar assembly encasing intumescent material for firestopping of pipes and cables through rated walls and floors.
   1. Fire Resistance: For use in 1 or 2 hour fire rated systems.
D. Plastic Pipe Device: Intumescent device for firestopping of plastic pipe and cables through rated walls and floors.
   1. Configuration: One-piece metal collar, with locking latch and bendable tabs to secure; equipped also for conventional anchoring.
   2. Fire Resistance: For use in 1, 2 or 3 hour fire rated systems.
E. Elastomeric Silicone Firestopping: Single component silicone elastomeric compound and compatible silicone sealant;
   1. Fire Resistance: For use in 1, 2 or 3 hour fire rated systems.
F. Foam Firestoppping: Single component silicone foam compound;
G. Fibered Compound Firestopping: Formulated compound mixed with incombustible non-asbestos fibers;
H. Fiber Firestopping: Mineral fiber insulation used in conjunction with elastomeric surface sealer forming airtight bond to opening;
I. Firestop Devices - Wrap Type: Mechanical device with incombustible filler and sheet stainless steel jacket, intended to be installed after penetrating item has been installed;
J. Firestop Devices - Cast-In Type: Sleeve and sealing material, intended to be cast in concrete floor forms or in concrete on metal deck, not requiring any additional materials to achieve penetration seal.
   1. Durability and Longevity: Permanent.
K. Intumescent Putty: Compound that expands on exposure to surface heat gain.
   1. Fire Resistance: For use in 1, 2 or 3 hour fire rated systems.
L. Reusable Firestopping: Removable intumescent compressible shapes, pillows, or blocks specifically tested in removable configuration;:
M. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

A. Do not begin installation until substrates have been properly prepared.
B. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.
C. Remove incompatible materials that could adversely affect bond.
D. Install backing materials to arrest liquid material leakage.
E. Verify that items penetrating fire rated assemblies are securely attached, including sleeves, supports, hangers, and clips.

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F. Verify that openings and adjacent areas are not obstructed by construction that would interfere with installation of firestopping, including ducts, piping, equipment, and other suspended construction.
G. Install masking and temporary coverings as required to prevent contamination or defacement of adjacent surfaces due to firestopping installation.

3.03 INSTALLATION

A. Non-rated assemblies shall be draft stopped.
B. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
C. Install so that openings are completely filled and material is securely adhered.
D. Where firestopping surface will be exposed to view, finish to a smooth, uniform surface flush with adjacent surfaces.
E. After installation is complete, remove combustible forming materials and accessories that are not part of the listed system.
F. Clean firestop materials off surfaces adjacent to openings as work progresses, using methods and cleaning materials approved in writing by firestop system manufacturer and which will not damage the surfaces being cleaned.
G. Do not cover firestopping with other construction until approval of authority having jurisdiction has been received.
H. Do not cover installed firestopping until inspected by authority having jurisdiction.
I. Install labelling required by code.
J. Install identification Labels for Through Penetration and Construction Joint Systems: Pressure sensitive self-adhesive vinyl labels, preprinted with the following information:
    1. The words "Warning - Through Penetration Firestop System - Do not Disturb. Notify Building Management of Any Damage."
    2. Listing agency's system number or designation.
    3. System manufacturer's name, address, and phone number.
    4. Installer's name, address, and phone number.
    5. General contractor's name, address, and phone number (if applicable).
    6. Date of installation.

3.04 CLEANING

A. Clean firestop materials off surfaces adjacent to openings as work progresses, using methods and cleaning materials approved in writing by firestop system manufacturer and which will not damage the surfaces being cleaned
B. Clean adjacent surfaces of firestopping materials.

3.05 PROTECTION

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

SECTION 21 1200 - FIRE-SUPPRESSION STANDPIPES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Valves.

1.02 REFERENCE STANDARDS

A. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems; 2024.

1.03 SUBMITTALS

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

B. Shop Drawings: Indicate supports, components, accessories, and sizes.
   1. Submit shop drawings and product data to Owner's insurance underwriter for approval.
   2. Submit proof of approval to Engineer.

C. Closeout Documents:
   1. Operation Data: Include appropriate manufacturer's data.
   2. Maintenance Data: Include servicing requirements and test schedule.
   3. Certificates: Provide certificate of compliance from authority having jurisdiction indicating approval of field acceptance tests.

1.04 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 14. Maintain one copy on site.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 VALVES

A. General Duty Valves: See Section 21 0523.

B. Specialty Valves:
   1. Pressure Reducing Valve:
      a. Angle type; brass finish with inner hydraulic controls; 2 inch size, thread to match fire department hardware, 400 psi inlet pressure, with threaded cap and chain of same material and finish.
   2. Function: Reduce high inlet pressure down to an adjustable preset output maintained independent of flow rate fluctuations.
   3. In-line or Angle Hose Valves:
      a. Cast bronze, 2-1/2 inch, NPS handwheel operated globe valve with grooved or threaded end connections, rated for 400 psi inlet pressure with outlet discharge field-set to hose inlet pressure.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 14.

C. Connect standpipe system to water source ahead of domestic water connection.

D. Where static pressure exceeds 100 psi but is less than 100 psi at any hose station, provide pressure orifice disc in discharge of hose station valve to prevent pressure on hose exceeding 90 psi.

E. Flush entire system of foreign matter.

3.02 FIELD QUALITY CONTROL

A. Perform field inspection and testing (Field Acceptance Test) in accordance with Section 01 4000.

B. Test entire system in accordance with NFPA 14.

C. Test shall be witnessed by Fire Marshal.

END OF SECTION

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SECTION 21 1300 - FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wet-pipe sprinkler system.
B. System design, installation, and certification.
C. Fire department connections.

1.02 REFERENCE STANDARDS

A. FM (AG) - FM Approval Guide; current edition.
B. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2015.
C. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2015.
D. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
E. NFPA 1963 - Standard for Fire Hose Connections; 2019.
F. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.
G. UL 405 - Standard for Safety Fire Department Connection Devices; Current Edition, Including All Revisions.

1.03 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.

1.04 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.

1.05 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

2.01 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.
   6. Substitutions: See Section 01 6000 - Product Requirements.

2.02 SPRINKLER SYSTEM

A. Sprinkler System: Provide coverage for building areas noted.
B. Occupancy: Light hazard; comply with NFPA 13.
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.
F. Pipe 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.
   3. Other Types: As required.

2.03 SPRINKLERS

A. Suspended Ceiling Type: Concealed pendant type with matching push on escutcheon plate.
   1. Response Type: Quick.
   2. Coverage Type: Standard.
   3. Finish: Brass.
   4. Escutcheon Plate Finish: Standard, Off White.
   5. Fusible Link: Glass bulb type temperature rated for specific area hazard.
B. Hard Ceiling Type: Concealed pendant type with matching push on escutcheon plate.
   1. Response Type: Quick.
   2. Coverage Type: Standard.
   3. Finish: Brass.
   4. Cover Plate Finish: Standard, Off White.
   5. Fusible Link: Glass bulb type temperature rated for specific area hazard.
C. Exposed Area Type: Upright 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. 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.
      b. Substitutions: See Section 01 6000 - Product Requirements.

2.04 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber-faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:
   1. Activate electric alarm.
   2. Test and drain valve.
   3. Replaceable internal components without removing valve from installed position.

B. Backflow Preventer: Reduced pressure principle valve assembly backflow preventer with drain and OS & Y gate valve on each end.
C. Test Connections:
    1. 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 0553.
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: Flush, 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. Configuration: Horizontal.
        c. Outlet: With pipe threads, 4 NPS.
            1) Location: Back.
        d. Finish: Brass or bronze.
        e. Signage: Raised or engraved lettering 1 inch minimum indicating system type.
        f. Manufacturers:
            1) Elkhart Brass Manufacturing Company, Inc: www.elkhartbrass.com.
            2) Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with referenced NFPA design and installation standard.
B. Install equipment in accordance with manufacturer's instructions.
C. Provide approved backflow preventer 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. Hydrostatically test entire system.
K. Require test be witnessed by Fire Marshal.

3.02 INTERFACE WITH OTHER PRODUCTS

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

END OF SECTION

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SECTION 21 3000 - FIRE PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Inline fire pump.
B. Jockey pump.

1.02 REFERENCE STANDARDS

A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
B. NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
C. NFPA 20 - Standard for the Installation of Stationary Pumps for Fire Protection; 2022.
D. NFPA 70-2017 - National Electrical Code; 2017.
E. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.
F. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.
G. UL 448 - Centrifugal Stationary Pumps for Fire-Protection Service; Current Edition, Including All Revisions.
H. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.
I. UL 1478 - Fire Pump Relief Valves; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
    1. Product Data: Provide manufacturers literature including general assembly, pump curves showing performance characteristics with pump and system, operating point indicated, NPSH curve, controls, wiring diagrams, and service connections.
    2. Indicate layout, general assembly, components, dimensions, weights, clearances, and methods of assembly.
    3. Certificates: Certify that fire pumps meet or exceed specified requirements at specified operating conditions and that the installation complies with regulatory requirements. Submit summary and results of shop tests performed in accordance with NFPA 20.
    4. Manufacturer's Instructions: Indicate support details, connection requirements, for fire pump system.
C. Closeout Documents:
    1. Operation Data: Include manufacturers instructions, start-up data, trouble-shooting check lists, for pumps, drivers, and controllers.
    2. Maintenance Data: Include manufacturers literature, cleaning procedures, replacement parts lists, and repair data for pumps, drivers and controllers.
    3. Project Record Documents: Record actual locations of components and accessories.
    4. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
        a. Extra Pump Gaskets/Screens/Seals: One set for each different pump model.
    5. Test Reports: Indicate results of hydrostatic test and field acceptance tests.

1.04 QUALITY ASSURANCE

A. Comply with NFPA 13 and NFPA 20; where requirements differ comply with the most stringent.
B. Design fire pump system under direct supervision of a Professional Engineer experienced in design of this work and licensed at the State in which the Project is located.
C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
E. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years experience.
F. Provide certificate of compliance from authority have jurisdiction indicating approval of field acceptance tests.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver fire pumps and components in factory packing. Comply with manufacturer's rigging and installation instructions.

B. Protect fire pumps and components from physical damage including effects of weather, water, and construction debris.
C. Provide temporary inlet and outlet caps, and maintain in place until installation.

PART 2 PRODUCTS

2.01 FIRE PUMPS

A. Inline Fire Pump:
   1. Manufacturers:
      a. Aurora, a Pentair brand; Series 911: www.pentair.com/#sle.
      b. Substitutions: See Section 01 6000 - Product Requirements.
   2. UL 448 and UL 778; vertical- or horizontal-mounted, single-stage, close-coupled centrifugal pump for maximum working pressure of 186 psi.
   3. Casing: Cast or ductile iron, or bronze with suction and discharge gauge port, casing wear ring, seal flush connection, drain plug, flanged suction and discharge.
   4. Impeller: Bronze, fully enclosed, keyed directly to motor shaft.
   5. Shaft: Solid alloy steel with bronze sleeve.
   6. Seal: Packing gland with minimum four rings graphite impregnated packing and bronze lantern rings, 230 degrees F maximum continuous operating temperature.
   7. Performance:
      a. Flow: 500 gpm, at 40 PSI.
      b. Motor: 20 hp, 460 volt, single phase, 60 Hz.
B. The pump shall be hydrostatically tested to twice the working pressure, but in no case less than 250 pounds per square inch. The pump unit shall be given a complete performance test and characteristic curves prepared from the test results shall be furnished.
C. The pump shall deliver not less than 150 percent of rated capacity at a pressure not less than 65 percent of the rated pressure. The pump shall be a vertical in-line type. The pump unit shall be listed and approved and meet all requirements of the National Fire Protection Association Pamphlet number 20.
D. Accessories:
   1. Eccentric suction reducer and OS&Y gate or butterfly valve on suction side of pump.
   2. Concentric increaser and check valve in pump discharge and OS&Y gate or butterfly valve on system side of check valve.
   3. Fire pump bypass fitted with OS&Y gate or butterfly valves and check valve.
   4. Main relief valve, UL 1478 and enclosed type waste cone.
   5. Suction pressure gauge, 4-1/2 inch diameter dial with snubber, valve cock and lever handle.
   6. Discharge pressure gauge mounted on board attached to pump, with snubber, valve cock and lever handle.
   7. 3/4 inch casing relief valve.
   8. Flow metering system for closed loop testing.

2.02 ELECTRIC MOTOR DRIVE

A. The motor shall be of such capacity that 115 percent of the full load ampere rating shall not be exceeded at any condition of the pump load. Ambient temperature shall not exceed 40°C when carrying full rated load continuously. Motor shall be capable of operating continuously with an overload of 15 percent without stress or injurious rise in temperature. Locked rotor current shall not exceed the values specified in N.F.P.A. Pamphlet number 20. Bearings shall be anti-friction, ball or roller type.
B. Controller: Limited service type with solid state starter, in NEMA 250 enclosure, including the following:
   1. Disconnect Switch: Externally operable, quick break type.
   2. Circuit Breaker: Comply with NFPA 20; minimum 65,000 amperes interrupting capacity.
   3. Motor Starter: Energized automatically through pressure switch or manually by externally operable handle.
   4. Running Period Timer: Keeps motor in operation when started automatically, for a minimum of seven minutes.
   5. Pilot Lamp: Indicates circuit breaker closed and power available.
   6. Alarm Relay: Energizes alarm to indicate circuit breaker open or power failure.

7. Switch Relay: For remote start.
8. Manual Selector Station: On enclosure marked "Automatic" and "Non-Automatic".

C. Power Transfer Switch
1. Suitable for generator or 2nd utility use. Factory assembled, wired tested and shipped as a complete unit.
2. Approvals
a. UL listed in accordance with UL218, Standard for Fire Pump Controllers, UL 1008 Automatic Transfer Switches, Factory Mutual, NEMA latest edition of NFPA 20 and NFPA 70-2017
3. Standard Features
a. Emergency power source disconnect sized for connected motor horsepower and voltage.
b. Fire pump circuit breaker
c. Overcurrent and phase failure/reversal monitoring.
d. 3-pole double throw transfer switch mechanism, electrically operated, mechanically held.
e. Control Module with the following:
1) Door mounted operator interface panel.
2) In-phase monitor.
3) Programmable engine exerciser.
4) Transfer switch data logging.
5) Differential voltage sensing on all phases of the normal power source.
6) Voltage sensing of emergency power source.
7) Frequency sensing of emergency power source.
8) Transfer time delay.
9) Retransfer from emergency to normal delay.
10) Cool-down timer
11) Instantaneous retransfer from emergency to normal if emergency fails and normal is available.
12) 3 second transfer restart delay
13) NO and NC engine control contacts to start generator set.
f. LED indicator lights for: Transfer switch normal, transfer switch emergency, emergency isolation switch open.
g. Test Selector Switch.
h. Transfer By-pass Switch
i. Silence Alarm Pushbutton
j. Emergency Isolating Switch Open and Transfer Switch in Emergency Audible Alarms.
k. Output contacts (NO and NC) for Generator Start, Emergency Isolating Switch Open and Transfer Switch position indicators.
l. NEMA Type 2 enclosure.

D. Manufacturer:
1. Firetrol FTA1000
2. Substitutions: See 01 6000 - Product Requirements.

2.03 JOCKEY PUMP

A. Manufacturers:
1. Aurora.
2. Substitutions: See Section 01 6000 - Product Requirements.

B. Electrically operated, horizontal or vertical, single or multi stage, turbine type centrifugal pump with standard open drip-proof horizontal motor.

C. Control by automatic jockey pump controller with full voltage starter and minimum run timer to start pump on pressure drop in system and stay in operation for minimum period of time. Fire pump shall start automatically on further pressure drop or on jockey pump failure.

D. Performance:
1. 10 GPM at 70 psi head.
2. 1 hp, 460 volts, 3 phase, 60 Hz.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with NFPA 20.
B. Provide access space around pumps for service; no less than minimum as recommended by manufacturer.
C. Piping: 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 base mounted pumps, provide supports under elbows on pump suction and discharge; see Section 21 0500.
D. Provide drains for bases and seals, piped to and discharging into floor drains.
E. Provide for connection to electrical service; see Section 26 0583.
F. Lubricate pumps before start-up.
G. Check, align, and certify pumps by qualified installer prior to start-up.
H. Provide supervisory alarm notifications using auxiliary dry contacts interconnected into fire alarm system for monitoring by Owner-designated central or off-site point of constant attendance; see Section 28 4600.

3.02 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements for additional requirements.
B. Perform hydrostatic tests, flushing, and field acceptance tests as specified in NFPA 20.
C. Perform field acceptance tests in the presence of Fire Marshal.

3.03 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals for additional submittals.
B. See Section 01 7900 - Demonstration and Training for additional requirements.
C. 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.

3.04 MAINTENANCE

A. See Section 01 7000 - Execution and Closeout Requirements for additional requirements.
B. Provide service and maintenance of equipment installed under this section for one year from the Date of Substantial Completion.

END OF SECTION

SECTION 22 0060 - PLUMBING & PIPING DEMOLITION

PART 1 GENERAL

1.01 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.

1.02 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.

1.03 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

2.01 MATERIALS AND EQUIPMENT

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

PART 3 EXECUTION

3.01 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.

3.02 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.

3.03 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.

3.04 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 0100 - PLUMBING GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 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.

1.02 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".

1.03 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.

1.04 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.

1.05 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.

1.06 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.

1.07 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. 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 one 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).

1.08 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. Manuals shall be 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. All sections shall be referenced with plastic tabs.

D. 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.

E. 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.

F. 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.

G. 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

H. Provide with the 3-ring binder hard copy manuals, two (2) copies of the manual on flash drive in PDF format. The electronic copies in PDF format shall be tabbed at each section for ease of finding specific items as listed in the manual. All items as described above that are found in the 3-ring binders shall also be found in the electronic

version. The electronic version shall be labeled indicating “O&M Manual”, “Project Name”, & “Contractor”.

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

1.09 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. Special piping systems including but not limited to compressed air piping shall not be less than two (2) man hours.
2. Plumbing systems including but not limited to water heaters, mixing valves, sump pumps and controls, interceptors, plumbing fixtures, and RO Water System shall not be less than eight (8) man hours.

1.10 MECHANICAL LIST OF CONSTRUCTION CLOSEOUT DOCUMENTS

A. This Contractor and their subcontractors should proceed immediately to fully complete the work as listed in Appendix 'A' 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 N/A where items don’t pertain.

1.11 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.

1.12 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.

1.13 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.

1.14 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.

1.15 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.

1.16 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.

1.17 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.

1.18 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.

1.19 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.

1.20 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

2.01 NOT USED

PART 3 EXECUTION

3.01 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
Special Piping Systems						
Plumbing						

Contractor	
Owner's Representative	

3.02 LIST OF CONSTRUCTION CLOSEOUT DOCUMENTS

DIVISION	DOCUMENT	DATE / INITIALS	APPROVED
22 00 00	Record drawings - Plumbing		
22 00 00	O&M Manuals - Plumbing		
22 00 00	Owners Instruction - Plumbing		
22 00 00	Documentation of domestic water system has been chlorinated and flushed.		
22 00 00	Valve tag schedule - Plumbing		
22 00 00	Provide stainless steel wall escutcheon on waste pipe through the wall for lavatories and sinks		
22 00 00	Adjust all wrist blade handles on sinks to 45 degrees		
22 00 00	Provide all equipment labels per specifications		
22 00 00	Contractor to ensure above ceiling piping is insulated		
22 00 00	Color match caulk water closets, urinals, mop basins, hand sinks, showers, etc., to match fixture		
22 00 00	Label all piping per specifications		
22 00 00	Insulate valves, strainers, unions, fittings per specifications.		
22 00 00	Submit factory/contractor start-up reports		
22 00 00	Calibrate infrared sensors on fixtures		
22 00 00	Clean all mechanical areas of debris, wipe down all fixtures and equipment. Remove all extra material and garbage from site.		
22 00 00	Ensure all holes existing and new have been patched. All openings remaining around pipe penetrations filled, caulked, and painted to match walls.		

END OF SECTION

SECTION 22 0150 - PLUMBING & PIPING MATERIALS & METHODS

PART 1 GENERAL

1.01 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.

1.02 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

2.01 NOT USED

PART 3 EXECUTION

3.01 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.

3.02 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.

3.03 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.

3.04 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.

3.05 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.

3.06 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.

3.07 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.

3.08 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

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SECTION 22 0513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.
B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2004.
C. NEMA MG 1 - Motors and Generators; 2017.
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 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.

1.04 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.

1.05 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.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 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

2.02 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. 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 1 limits for insulation class, service factor, and motor enclosure type.
    4. Motors with frame sizes 254T and larger: Energy efficient type.

D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor.
E. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 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 dust collection systems: Totally enclosed type explosion proof.
C. Motors driven by Variable Frequency Drives shall in be listed for the application.

2.04 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.

2.05 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.

2.06 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.

2.07 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 1 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 2913.
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 1.
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.

2.08 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

3.01 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

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SECTION 22 0517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe sleeves.

B. Pipe sleeve-seals.

1.02 REFERENCE STANDARDS

A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).

1.03 SUBMITTALS

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

B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.04 QUALITY ASSURANCE

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

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.

1.05 DELIVERY, STORAGE, AND HANDLING

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

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 PIPE SLEEVES

A. Manufacturers:
   1. Flexicraft Industries; Pipe Wall Sleeve: www.flexicraft.com/#sle.
   2. Substitutions: See Section 01 6000 - Product Requirements.

B. Vertical Piping:
   1. Sleeve Length: 1 inch above finished floor.
   2. Provide sealant for watertight joint.

C. Pipe Passing Through Below Grade Exterior Walls:
   1. Zinc coated or cast iron pipe.
   2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.

D. Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:
   1. Galvanized steel pipe or black iron pipe with asphalt coating.
   2. Connect sleeve with floor plate except in mechanical rooms.

E. Clearances:
   1. Provide allowance for insulated piping.
   2. Wall, Floor, Partitions, and Beam Flanges: 1 inch greater than external pipe diameter.
   3. All Rated Openings: Caulked tight with fire stopping material complying with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

2.02 PIPE-SLEEVE SEALS

A. Manufacturers:
   1. Flexicraft Industries; PipeSeal: www.flexicraft.com/#sle.
   2. Metraflex, MetraSeal.
   3. Substitutions: See Section 01 6000 - Product Requirements.

B. Sealing Compounds:
   1. Provide packing and sealing compound to fill pipe to sleeve thickness.
   2. Combined packing and sealing compounding to match partition fire-resistance hourly rating.

PART 3 EXECUTION

3.01 INSTALLATION

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

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

C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
D. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
    1. Underground Piping: Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.
    2. All Rated Openings: Caulk tight with fire stopping material complying with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.
E. Manufactured Sleeve-Seal Systems:
    1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
    2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
    3. Locate piping in center of sleeve or penetration.
    4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
    5. Tighten bolting for a water-tight seal.
    6. Install in accordance with manufacturer's recommendations.
F. 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.

3.02 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 22 0519 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water meters.
B. Flow meters.
C. Pressure gauges.
D. Thermometers.
E. Pressure-temperature test plugs.

1.02 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 2020).
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; 2020.
E. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service; Current Edition, Including All Revisions.

1.03 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.

1.04 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

2.01 FLOWMETERS (FMD)

A. Manufacturers:
    1. Gerand Engineering: www.gerand.com
    2. Substitutions: See Section 01 6000 - Product Requirements.
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% of actual flow. Orifice type flowmeter shall have a pressure drop at indicated flow not exceeding 25" of water.
D. Calibrated ASME MFC-3M venturi orifice plate and flanges with valved taps, chart for conversion of differential pressure readings to flow rate, with pressure gauge in case.

2.02 PRESSURE GAUGES

A. Manufacturers:
    1. Dwyer Instruments, Inc: www.dwyer-inst.com.
    2. Substitutions: See Section 01 6000 - Product Requirements.
B. Pressure Gauges: ASME B40.100 metal case, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
    1. Case: Steel with brass bourdon tube.
    2. Size: 4-1/2 inch diameter.
    3. Mid-Scale Accuracy: One (1) percent.
    4. Scale: Psi.
C. Pressure Gauge Tappings:
    1. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.
    2. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.

2.03 THERMOMETERS

A. Manufacturers:
    1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
    2. Weiss Instruments, LLC: www.weissinstruments.com/#sle.

3. WIKA Instruments Solar Industrial Thermometers: www.wika.com
4. Substitutions: See Section 01 6000 - Product Requirements.

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.

D. Supports:
1. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

2.04 TEST PLUGS:

A. 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.

PART 3 EXECUTION

3.01 INSTALLATION

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

B. Install flowmeters in accessible locations for admustment and measurment 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.

3.02 SCHEDULES

A. Pressure Gauges, Location and Scale Range:
1. Pumps, 0 to 100 psi.
2. Pressure reducing valves, 0 to 100 psi.

B. Stem Type Thermometers, Location and Scale Range:
1. Headers to central equipment, 0 to 100 degrees F.
2. Domestic hot water supply and recirculation, 0 to 200 degrees F.

C. Flow Meters, Location:
1. Domestic recirculation lines as indicated on drawings.

END OF SECTION

SECTION 22 0523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Ball valves.
B. Check valves.

1.02 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; 2020.
D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2018.
E. ASME B31.9 - Building Services Piping; 2020.
F. ASME BPVC-IX - Qualification Standard for Welding, Brazing, and Fuzing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators - Welding Brazing and Fusing Qualifications; 2019.
G. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications; 2022.
H. AWWA C606 - Grooved and Shouldered Joints; 2015.
I. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
J. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.
K. NSF 61 - Drinking Water System Components - Health Effects; 2017.
L. NSF 372 - Drinking Water System Components - Lead Content; 2016.

1.03 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.

1.04 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.

1.05 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

2.01 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: 2 NPS (50 DN) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
    4. Swing Check (Pump Outlet):
        a. 2 NPS and Smaller: Bronze swing check valves with bronze or nonmetallic 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. Required Valve End Connections for Non-Wafer Types:
    1. Steel Pipe:
        a. 2 inch and Smaller: Threaded ends.
    2. Copper Tube:
        a. 2 inch and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
        b. 2-1/2 inch to 4 inch: Grooved or flanged ends except where threaded valve-end option is indicated in valve schedules below.
        c. 5 inch and Larger: Grooved or flanged ends.
F. Low Pressure, Compressed Air Valves 150 psi or Less:
    1. 2 inch and Smaller:
        a. Ball: Two piece, full port, brass or bronze with brass trim.
G. 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.
H. Sanitary Waste and Storm Drainage Water Valves:
    1. 2-1/2 inch and Larger:
        a. Iron Swing Check with Closure Control: Class 125, lever and spring.

2.02 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. Bronze Valves:
    1. Fabricate from dezincification resistant material.
    2. Copper alloys containing more than 15 percent zinc are not permitted.
I. Source Limitations: Obtain each valve type from a single manufacturer.
J. Valve manufacturers unless otherwise noted:

1. Apollo
2. Jomar
3. NIBCO
4. Hammond
5. Milwaukee
6. Watts
7. Substitutions: See Section 01 6000 - Product Requirements.

2.03 BRASS, BALL VALVES

A. Two Piece full port with Brass Trim:
1. Comply with MSS SP-110.
2. WSP Rating: 150 psi.
3. WOG Rating: 600 psi.
4. Body: Forged, dezincified brass, low lead compliant.
5. Seats: PTFE.
6. Stem: Stainless Steel.
7. Ball: Stainless steel.
8. Operator: Lockable handle, memory stop, and stem extension where required.

2.04 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 trim.
1. WSP Rating: 150 psi.
2. WOG Rating: 600 psi.
3. Body: Forged bronze.
4. Ends Connections: Pipe thread or solder.
5. Seats: PTFE.
6. Stem: Bronze, blowout proof.
7. Ball: Chrome plated brass.
8. Operator: Provide lockable handle and stem extension.

2.05 STAINLESS STEEL, BALL VALVES

A. One Piece, Standard Port with Stainless-Steel Trim:
1. Comply with MSS SP-110.
2. WSP Rating: 150 psi.
3. CWP Rating: 1,000 psi.
4. Seats: PTFE.
5. Stem: Stainless steel, blowout proof.
6. Ball: Stainless steel.
7. End Connections: Threaded.
8. Operator: Lockable handle.

2.06 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 125: CWP Rating: 200 psig (1380 kPa) and 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. Ends: Threaded or soldered as indicated.
5. Disc: Bronze.

PART 3 EXECUTION

3.01 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.

3.02 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.

END OF SECTION

SECTION 22 0553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 REFERENCE STANDARDS

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

1.03 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

2.01 IDENTIFICATION APPLICATIONS

A. Control Panels: Nameplates.
B. Heat Transfer Equipment: Nameplates.
C. Piping: Pipe markers.
D. Pumps: Nameplates.
E. Tanks: Nameplates.
F. Valves: Tags and ceiling tacks where located above lay-in ceiling.
G. Water Treatment Devices: Nameplates.

2.02 NAMEPLATES

A. Manufacturers:
    1. Seton Identification Products: www.seton.com.
    2. Substitutions: See Section 01 6000 - Product Requirements.
B. Description: Laminated three-layer plastic with engraved letters.
    1. Letter Color: Black.
    2. Letter Height: 1/2 inch.
    3. Background Color: Green.
    4. Nameplate Height: 3/4 inch.

2.03 TAGS

A. Manufacturers:
    1. Advanced Graphic Engraving: www.advancedgraphicengraving.com.
    2. Brimar Industries, Inc.: www.pipemarker.com/#sle.
    3. Seton Identification Products: www.seton.com.
    4. Substitutions: See Section 01 6000 - Product Requirements.
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.

2.04 PIPE MARKERS

A. Manufacturers:
   1. Brady Corporation: www.bradycorp.com.
   2. Brimar Industries, Inc: www.pipemarker.com/#sle.
   3. Seton Identification Products: www.seton.com.
   4. Substitutions: See Section 01 6000 - Product Requirements.

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. Compressed Air: White text on blue background.
      b. Water; Potable, Cooling, Boiler Feed, and Other: White text on green background.
   3. Tertiary: Other Details.
      a. Directional flow arrow band over pipe circumference.

2.05 CEILING TACKS

A. Manufacturers:
   1. Craftmark: www.craftmarkid.com.
   2. Seton Identification Products: www.seton.com.
   3. Substitutions: See Section 01 6000 - Product Requirements.

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

C. Color code as follows:
   1. Plumbing Valves: Green.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive identification products.

B. Prepare surfaces for stencil painting, see Section 09 9123.

3.02 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.
140° F Hot Water	140° H.W.
Recirculating Hot Water	R.H.W.
Sanitary Drain	SAN. DRAIN

Storm Drain	STORM DRAIN
Compressed Air	AIR
Natural Gas	NAT. GAS
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

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SECTION 22 0716 - PLUMBING EQUIPMENT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flexible elastomeric cellular insulation.
B. Flexible glass fiber insulation.
C. Rigid glass fiber insulation.
D. Jacketing and accessories.

1.02 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.
C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2017.
D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2023.
E. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).
F. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2022a.
G. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).
H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.
I. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.
J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.
C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.04 QUALITY ASSURANCE

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

1.05 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.

1.06 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

2.01 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.

2.02 FLEXIBLE GLASS FIBER INSULATION

A. Manufacturers:
    1. CertainTeed Corporation: www.certainteed.com.
    2. Johns Manville Corporation: www.jm.com.
    3. Knauf Insulation: www.knaufinsulation.com.

4. Owens Corning Corp: www.owenscorning.com.
5. Substitutions: See Section 01 6000 - Product Requirements.

B. Insulation: ASTM C553; flexible, noncombustible.
1. K Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
2. Maximum Service Temperature: 450 degrees F.
3. Maximum Water Vapor Absorption: 5.0 percent by weight.

C. Vapor Barrier Jacket: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
2. Secure with self-sealing longitudinal laps and butt strips.

2.03 RIGID GLASS FIBER INSULATION

A. Manufacturers:
1. CertainTeed Corporation: www.certainteed.com.
2. Johns Manville Corporation: www.jm.com.
3. Knauf Insulation: www.knaufinsulation.com.
4. Owens Corning Corp: www.owenscorning.com.
5. Substitutions: See Section 01 6000 - Product Requirements.

B. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
1. K Value: 0.25 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.

C. Vapor Barrier Jacket:
1. Kraft paper reinforced 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 self-sealing longitudinal laps and butt strips.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturers:
1. Aeroflex USA, Inc: www.aeroflexusa.com.
2. Armacell LLC: www.armacell.us.
3. Substitutions: See Section 01 6000 - Product Requirements

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.

2.05 JACKETING AND ACCESSORIES

A. PVC Plastic:
1. Manufacturers:
a. Johns Manville Corporation: www.jm.com.
b. Substitutions: See Section 01 6000 - Product Requirements.
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.

B. Aluminum Jacket:
1. 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.
2. Thickness: 0.016 inch sheet.
3. Finish: Embossed.

4. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment has been tested before applying insulation materials.
B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 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. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
H. Inserts and Shields:
    1. Application: Equipment 1-1/2 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.
    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.
I. Finish insulation at supports, protrusions, and interruptions.
J. Exterior Applications:
    1. Provide vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement.
    2. Provide vapor barrier jacket.
    3. Cover with aluminum.
K. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.
L. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
M. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

3.03 SCHEDULES

A. Plumbing Systems:
    1. Water Meters.
        a. Cellular Foam Insulation: 3/4 inches thick.

END OF SECTION

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SECTION 22 0719 - PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Glass fiber insulation.

B. Jacketing and accessories.

1.02 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.

B. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2023.

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; 2021a.

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.

1.03 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.

1.04 QUALITY ASSURANCE

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

1.05 DELIVERY, STORAGE, AND HANDLING

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

1.06 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

2.01 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.

2.02 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.
5. Substitutions: See Section 01 6000 - Product Requirements.

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.

2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturers:

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

3. Substitutions: See Section 01 6000 - Product Requirements.

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.

2.04 JACKETING AND ACCESSORIES

A. PVC Plastic Jacket:
   1. Manufacturers:
      a. Johns Manville Zeston 2000 Series White PVC or equal.
      b. Substitutions: See Section 01 6000 - Product Requirements.
   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

3.01 EXAMINATION

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

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

3.02 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" 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 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. 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". 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” and smaller, no insert is required below the insulation. Both inserts and saddles shall be provided for all piping 2" and larger.
      b. On domestic water, 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 10 inches.
      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 flame and 50 smoke.
   2. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 8400.

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. Buried Piping: Provide 1/2" thick elastomeric thermal pipe insulation on pipe sizes up to 1-1/2" in diameter. Install per manufacturers recommendations. Provide PVC pipe conduit to encase insulated pipe.

N. Equipment Insulation:
1. Water meter shall be insulated with 3/4" 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.

3.03 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 inch and 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 inch and greater	1-1/2 inch

B. 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".

END OF SECTION

SECTION 22 0784 - MECHANICAL FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Firestopping systems.

B. Firestopping of all mechanical through and membrane penetrations in fire-resistance rated and smoke-resistant assemblies , whether indicated on drawings or not .

1.02 REFERENCE STANDARDS

A. ASTM E 814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops; 2009.

B. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.

C. FM 4991 - Approval of Firestop Contractors; Factory Mutual Research Corporation; 2001.

D. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.

E. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.

F. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.03 SUBMITTALS

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

B. Shop Drawings:

1. Schedule of Firestopping: List each type of penetration.
2. Product Data: Provide data on product characteristics.

C. Closeout Documents:

1. Certificate from authority having jurisdiction indicating approval of materials used.

1.04 QUALITY ASSURANCE

A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.

1. Listing in the current-year classification or certification books of UL, FM, or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.
2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.

B. Installer Qualifications: Company specializing in performing the work of this section and:

1. Approved by Factory Mutual Research under FM Standard 4991, Approval of Firestop Contractors , or meeting any two of the following requirements:.
2. With minimum 3 years documented experience installing work of this type.
3. Able to show at least 5 satisfactorily completed projects of comparable size and type.
4. Licensed by authority having jurisdiction.

1.05 MOCK-UP

A. Install one firestopping assembly representative of each fire rating design required on project.

B. Obtain approval of authority having jurisdiction before proceeding.

C. If accepted, mock-up will represent minimum standard for the Work.

D. If accepted, mock-up may remain as part of the Work. Remove and replace mock-ups not accepted.

1.06 SCOPE / APPLICATION

A. Provide installed firestop protects that limit the spread of fire, heat, smoke, and gasses through otherwise unprotected openings in rated assemblies, including walls, partitions, floors, roof/ceilings, and similar locations. restoring the integrity of the fire rated construction to its original fire rating.

B. Provide firestop systems listed for the specific combination of fire rated construction, type of penetrating item, annular space requirements, and fire rating, and the following criteria:

1. F-Rating: Equal to or greater than the fire-resistance rating of the assembly in which the firestopping will be installed.
2. T-Rating: In habitable areas where penetrating items are exposed to potential contact with materials on fire side(s) of rated assembly, T-rating must equal its F-rating.
3. L-Rating: L-rating of 1 cfm per linear foot (5.5 cu m/h/m) maximum at ambient temperatures.
4. Wall Penetrations: Systems must be symmetrical, with the same rating from both sides of the wall.

1.07 FIELD CONDITIONS

A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. A/D Fire Protection Systems Inc: www.adfire.com.
B. 3M Fire Protection Products: www.3m.com/firestop.
C. Hilti, Inc: www.us.hilti.com.
D. Nelson FireStop Products: www.nelsonfirestop.com.
E. Specified Technologies, Inc: www.stifirestop.com.
F. Pecora Corporation: www.pecora.com.
G. Thermafiber, Inc: www.thermafiber.com.
H. RectorSeal: www.rectorseal.com.
I. International Protective Coatings Corp.

2.02 THROUGH PENETRATION FIRESTOP SYSTEMS

A. Firestopping: Any material meeting requirements.
    1. Fire Ratings: Use any system listed by UL or tested in accordance with ASTM E 814 that has F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and that meets all other specified requirements.
    2. Fire Ratings: See Drawings for required systems and ratings.

2.03 MATERIALS

A. Firestopping Sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
B. Cast-in-Place Devices: Firestopping device for use prior to a concrete pour. Adjustable height with pull tabs, straight edge design for close placement to walls and adjacent devices.
    1. Fire Resistance: For use in 1, 2, or 3 hour fire rated systems.
C. One piece metal collar assembly encasing intumescent material for firestopping of pipes and cables through rated walls and floors.
    1. Fire Resistance: For use in 1 or 2 hour fire rated systems.
D. Plastic Pipe Device: Intumescent device for firestopping of plastic pipe and cables through rated walls and floors.
    1. Configuration: One-piece metal collar, with locking latch and bendable tabs to secure; equipped also for conventional anchoring.
    2. Fire Resistance: For use in 1, 2 or 3 hour fire rated systems.
E. Elastomeric Silicone Firestopping: Single component silicone elastomeric compound and compatible silicone sealant;
    1. Fire Resistance: For use in 1, 2 or 3 hour fire rated systems.
F. Foam Firestoppping: Single component silicone foam compound;
G. Fibered Compound Firestopping: Formulated compound mixed with incombustible non-asbestos fibers;
H. Fiber Firestopping: Mineral fiber insulation used in conjunction with elastomeric surface sealer forming airtight bond to opening;
I. Firestop Devices - Wrap Type: Mechanical device with incombustible filler and sheet stainless steel jacket, intended to be installed after penetrating item has been installed;
J. Firestop Devices - Cast-In Type: Sleeve and sealing material, intended to be cast in concrete floor forms or in concrete on metal deck, not requiring any additional materials to achieve penetration seal.
    1. Durability and Longevity: Permanent.
K. Intumescent Putty: Compound that expands on exposure to surface heat gain.
    1. Fire Resistance: For use in 1, 2 or 3 hour fire rated systems.
L. Reusable Firestopping: Removable intumescent compressible shapes, pillows, or blocks specifically tested in removable configuration;:
M. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

A. Do not begin installation until substrates have been properly prepared.
B. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.
C. Remove incompatible materials that could adversely affect bond.
D. Install backing materials to arrest liquid material leakage.
E. Verify that items penetrating fire rated assemblies are securely attached, including sleeves, supports, hangers, and clips.
F. Verify that openings and adjacent areas are not obstructed by construction that would interfere with installation of firestopping, including ducts, piping, equipment, and other suspended construction.
G. Install masking and temporary coverings as required to prevent contamination or defacement of adjacent surfaces due to firestopping installation.

3.03 INSTALLATION

A. Non-rated assemblies shall be draft stopped.
B. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
C. Install so that openings are completely filled and material is securely adhered.
D. Where firestopping surface will be exposed to view, finish to a smooth, uniform surface flush with adjacent surfaces.
E. After installation is complete, remove combustible forming materials and accessories that are not part of the listed system.
F. Clean firestop materials off surfaces adjacent to openings as work progresses, using methods and cleaning materials approved in writing by firestop system manufacturer and which will not damage the surfaces being cleaned.
G. Do not cover firestopping with other construction until approval of authority having jurisdiction has been received.
H. Do not cover installed firestopping until inspected by authority having jurisdiction.
I. Install labelling required by code.
J. Install identification Labels for Through Penetration and Construction Joint Systems: Pressure sensitive self-adhesive vinyl labels, preprinted with the following information:
    1. The words "Warning - Through Penetration Firestop System - Do not Disturb. Notify Building Management of Any Damage."
    2. Listing agency's system number or designation.
    3. System manufacturer's name, address, and phone number.
    4. Installer's name, address, and phone number.
    5. General contractor's name, address, and phone number (if applicable).
    6. Date of installation.

3.04 CLEANING

A. Clean firestop materials off surfaces adjacent to openings as work progresses, using methods and cleaning materials approved in writing by firestop system manufacturer and which will not damage the surfaces being cleaned
B. Clean adjacent surfaces of firestopping materials.

3.05 PROTECTION

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

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SECTION 22 1005 - PLUMBING PIPING

PART 1 GENERAL

1.01 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. Process water.
G. Pipe flanges, unions, and couplings.
H. Pipe hangers and supports.
I. Pipe sleeve-seal systems.
J. Pressure reducing valves.
K. Pressure relief valves.
L. Strainers.

1.02 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; 2018.
C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2018.
D. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes; 2018.
E. ASME B31.9 - Building Services Piping; 2020.
F. ASME BPVC-IX - Qualification Standard for Welding, Brazing, and Fuzing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators - Welding Brazing and Fusing Qualifications; 2019.
G. ASSE 1003 - Performance Requirements for Water Pressure Reducing Valves for Potable Water Distribution Systems; 2020.
H. ASTM B32 - Standard Specification for Solder Metal; 2020.
I. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes; 2020.
J. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2020.
K. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
L. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2016.
M. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2016.
N. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
O. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80; 2020.
P. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020.
Q. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2020.
R. 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.
S. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2016.
T. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.
U. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2017.
V. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2017, with Errata (2018).
W. AWWA C550 - Protective Interior Coatings for Valves and Hydrants; 2017.
X. AWWA C651 - Disinfecting Water Mains; 2014, with Addendum (2020).
Y. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2018.

Z. 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; 2012.
AA. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2015.
BB. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2015.
CC. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018.
DD. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; 2012.
EE. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.
FF. NSF 61 - Drinking Water System Components - Health Effects; 2017.
GG. NSF 372 - Drinking Water System Components - Lead Content; 2016.
HH. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 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

1.04 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.

1.05 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.

1.06 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 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.

2.02 SANITARY WASTE PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: CISPI 301, hubless.
   1. Fittings: Cast iron.
   2. Joints: CISPI 310, neoprene gasket and heavy duty stainless steel clamp and shield assemblies.
B. PVC Pipe: ASTM D2665
   1. Fittings: PVC
   2. Joints: Solvent welded, ASTM D2665 with solvent cement

2.03 SANITARY WASTE PIPING, ABOVE GRADE

A. PVC Pipe: ASTM D2665.
   1. Fittings: PVC.
   2. Joints: Solvent welded, with ASTM D2564 solvent cement.
B. CPVC Pipe: ASTM F 2618 SPEARS LabWaste
   1. Fittings: CPVC.
   2. Joints: Solvent weld with pipe manufacturers approved solvent.

2.04 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.

2.05 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) Viega LLC: www.viega.com.
         2) Substitutions: See Section 01 6000 - Product Requirements.

2.06 PROCESS WATER PIPING, ABOVE GRADE

A. Reverse Osmosis Water:
   1. Low Extractable PVC Piping: ASTM D1785
   2. Low Extractable PVC Fittings: ASTM D2467
   3. Solvent-cement joining manufacturers approved product.
   4. Valves and accessories provided by pipe manufacturer and approved for use in system.
   5. Manufacturers:
      a. Spears
      b. Charlotte
      c. US Plastic
      d. Substitutions: See Section 01 60 00 - Product Requirements.

2.07 STORM DRAINAGE PIPING, BURIED WITHIN 5 FEET OF BUILDING

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

2.08 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.

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

2.10 PIPE HANGERS AND SUPPORTS

   1. Manufacturers:
      a. Anvil
      b. Michigan
      c. Substitutions: See Section 01 60 00 - Product Requirements.

2. Hangers and strut located in corrosive areas shall be type 316 stainless steel with stainless steel hardware.
    a. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
        1) Cold and Hot Pipe Sizes 6 inch and Larger: Double hangers.
    b. Trapeze Hangers: Welded steel channel frames attached to structure.
    c. Vertical Pipe Support: Steel riser clamp.
    d. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.
3. Roof pipe supports:
    a. Compact pipe support: Piping shall be supported by a polyethylene, or vulcanized recycled rubber block with an integral strut channel for receiving standard 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.
    b. Pipe stands: Piping 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.
    c. 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.
    d. Manufacturers:
        1) Erico
        2) Advanced Support Products
        3) Substitutions: See Section 01 60 00 - Product Requirements.

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. Wall Support for Pipe Sizes to 3 inch: Cast iron hook.
4. Wall Support for Pipe Sizes 4 inch and Over: Welded steel bracket and wrought steel clamp.
5. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
6. 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. Wall Support for Pipe Sizes Up to 3 inch: Cast iron hook.
5. Wall Support for Pipe Sizes 4 inch and Larger: Welded steel bracket and wrought steel clamp.
6. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
7. Floor Support for Hot Pipe Sizes to 4 inch: Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
8. 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.

2.11 PIPE SLEEVE-SEAL SYSTEMS

A. Manufacturers:
1. Link-Seal an EnPro Industries Company: www.linkseal.com
2. The Metraflex Company; MetraSeal: www.metraflex.com/#sle.
3. Substitutions: See Section 01 6000 - Product Requirements.

B. Modular Mechanical Seals:
   1. Elastomer-based interlocking links continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
   2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
   3. Size and select seal component materials in accordance to service requirements.
   4. Glass reinforced plastic pressure end plates.

2.12 PRESSURE REDUCING VALVES

A. Manufacturers:
   1. Watts Regulator Company: www.wattsregulator.com.
   2. Substitutions: See Section 01 6000 - Product Requirements.
B. 2 inch and Smaller:
   1. ASSE 1003, bronze body, stainless steel, and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single union ends.
   2. Pressure Reducing Pilot-Operator:
      a. Operating Range: 5 to 50 psi.
      b. Connected into brass or bronze pilot piping and fittings.
      c. Fixed flow restrictor, pressure gauges, and isolation valves.
C. 2 inch and Larger:
   1. ASSE 1003, cast iron body with interior lining complying with AWWA C550, bronze fitted, elastomeric diaphragm and seat disc, flanged.
   2. Pressure Reducing Pilot-Operator:
      a. Operating Range: 5 to 50 psi.
      b. Connected into brass or bronze pilot piping and fittings.
      c. Fixed flow restrictor, strainer, pressure gauges, and isolation valves.

2.13 PRESSURE RELIEF VALVES

A. Manufacturers:
   1. Watts Regulator Company; _____: www.wattsregulator.com/#sle.
   2. Substitutions: See Section 01 6000 - Product Requirements.
B. ANSI Z21.22, AGA certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.

2.14 STRAINERS

A. Manufacturers:
   1. Titan Flow Control, Inc.: www.titan.com
   2. Substitutions: See Section 01 6000 - Product Requirements.
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 150, 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 iron body, Y pattern with 1/16 inch stainless steel perforated screen.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

A. Remove scale and dirt, on inside and outside, before assembly.
B. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. The contractor shall note PVC 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 0516.
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 0719.
J. Provide access where valves and fittings are not exposed.
    1. Coordinate size and location of access doors with Section 08 3100.
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. Paint exterior steel piping with two coats of Rust-Oleum of color matching architectural metal or utility served.
M. Provide support for utility meters in accordance with requirements of utility companies.
N. Prepare exposed, unfinished pipe, fittings, supports, and accessories for finish painting.
    1. See Section 09 9123 for painting of interior plumbing systems and components.
    2. See Section 09 9113 for painting of exterior plumbing systems and components.
O. 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.
P. Install valves with stems upright or horizontal, not inverted. See Section 22 0523.
Q. Install water piping to ASME B31.9.
R. 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.
S. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
T. Polypropylene Piping:
    1. All installation of polypropylene piping shall be conducted by a factory trained installer.
    2. The contractor shall coordinate and solicit a factory representative to conduct two (2) site inspections during the installation phase of construction. The contractor shall remediate any issues discovered during the inspection at no additional cost to the owner.
U. Sleeve pipes passing through partitions, walls, and floors.
V. 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.

W. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.9.
2. Support horizontal piping as per local plumbing codes.
   a. Steel Pipe

3/4 inch and smaller	6 foot centers
1 inch through 1 1/2 inch	8 foot centers
2 inch and larger	10 foot centers

   b. Copper Pipe

1 1/2 inch and smaller	4 foot centers
2 inch and larger	8 foot centers

   c. Plastic Pipe (PVC, CPVC & ABS)

All pipe sizes	32 inch centers

   d. Plastic Pipe (Polypropylene, PEX - Refer to Manufacturer Recommendation but no greater than listed below)

1 inch and less	32 inch centers
1 1/4 and larger	4 foot centers

   e. Cast Iron Soil Pipe

All sizes	4 foot centers

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. 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 plumbing systems and components is specified in Section 09 9123.
    b. Painting of exterior plumbing systems and components is specified in Section 09 9113.
11. Provide hangers adjacent to motor-driven equipment with vibration isolation; see Section 22 0548.
12. All hangers shall be oversized to encircle the piping and the insulation. Insulation shall be continuous through all hangers.

X. Pipe Sleeve-Seal Systems:
1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
3. Locate piping in center of sleeve or penetration.
4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
5. Tighten bolting for a watertight seal.
6. Install in accordance with manufacturer's recommendations.

Y. 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.

3.04 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 shall meet flame and smoke spread ratings of 25/50
    2. CPVC
F. High Temperature Water (130 degrees F and higher)
    1. Waste from commercial kitchens, boiler blowdown, steam humidifiers, etc. shall be 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.

3.05 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.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Disinfect water distribution system in accordance with Section 33 0110.58.
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.

3.07 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.
    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 1006 - PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Drains.
B. Cleanouts.
C. Hose bibbs.
D. Hydrants.
E. Backflow preventers.
F. Double check valve assemblies.
G. Water hammer arrestors.
H. Sumps.
I. Sanitary waste interceptors.
J. Digital Mixing Valves.
K. Relief valves.
L. Air vents.
M. Thermostatic Recirculation Valve (TRV)

1.02 REFERENCE STANDARDS

A. ASME A112.6.3 - Floor and Trench Drains; 2019.
B. ASME A112.6.4 - Roof, Deck, and Balcony Drains; 2008 (Reaffirmed 2012).
C. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers; 2017.
D. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent; 2009.
E. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers; 2011.
F. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance; 2011 (Reaffirmed 2016).
G. DIN 19580 - Drainage channels for vehicular and pedestrian areas - Durability, mass per unit area and evaluation of conformity; 2010.
H. NSF 61 - Drinking Water System Components - Health Effects; 2017.
I. NSF 372 - Drinking Water System Components - Lead Content; 2016.

1.03 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.

1.04 QUALITY ASSURANCE

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

1.05 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

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

2.02 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
7. Substitutions: See Section 01 6000 - Product Requirements.

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. Roof Overflow Drains:
1. Lacquered cast iron body and clamp collar and bottom clamp ring; pipe extended to 2 inches above flood elevation.
2. Provide overflow roof drains equal to Josam 21500-16 or MIFAB R-1200-W2. No other manufacturers shall be acceptable.

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

E. 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, round adjustable nickel-bronze strainer and separate deep seal trap. For floor drains in mechanical rooms, provide a round drain with recessed strainer.

F. Sediment Bucket Floor Drain:
1. ASME A112.6.3; 9" diameter lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable round nickel bronze strainer with removable perforated sediment bucket. Similar to Zurn Model #ZN550-Y.

G. 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, roundround , adjustable nickel-bronze strainer and separate deep seal trap. For emergency floor drains (i.e., floor drains located in restrooms, under emergency shower/eyewash euquipment, or in laundry rooms not serving as a receptor), provide trap seal.

H. Prefabricated Trench Drain (TD): Trench drain system assembled from factory fabricated, polymer concrete castings in standard lengths and variable depths, with integral joint flanges and integral grating support rails; includes joint gaskets and grating.
1. Basis of Design: ACO Polymer Products, Inc., KlassikDrain: www.acousa.com.
2. Load Class: DIN 19580, Class E.
3. Grating Material and Style: Longitudinally slotted ductile iron.
4. Trench Width: 4 inches.
5. Trench Section Length: 39 inches and 19-1/2 inches.
6. Grating Support Rail: Stainless steel.
7. Accessories:
a. Oval to round pipe connection.
b. Vertical outlet strainer.

I. Floor Sink :

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

2.03 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
   7. Substitutions: See Section 01 6000 - Product Requirements.

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.

2.04 HOSE BIBBS

A. Manufacturers:
   1. Jay R. Smith Manufacturing Company: www.jrsmith.com/#sle.
   2. Murdock Manufacturing, Inc: www.murdockmfg.com/#sle.
   3. Watts Regulator Company: www.wattsregulator.com/#sle.
   4. Zurn Industries, LLC: www.zurn.com.
   5. Chicago
   6. Substitutions: See Section 01 6000 - Product Requirements.

B. Interior Hose Bibbs:
   1. Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, chrome-plated where exposed with handwheel, integral vacuum breaker in compliance with ASSE 1011.
   2. Similar to Chicago Faucets 952-CP.

C. Interior RO Water Hose Bibbs:
   1. Pure water faucet, polypropylene valve, polypropylene needle cartridge, wall mounted, chrome plated brass wall flange, shank, riser and coupling outer shell. 3/8" NPT polypropylene male thread inlet.
   2. Similar to Chicago Faucets 829-ACP.

D. Interior Mixing Type Hose Bibbs:
   1. Bronze or brass, wall mounted, double service faucet with hose thread spout, integral stops, chrome-plated where exposed with handwheels, and vacuum breaker in compliance with ASSE 1011.

2.05 HYDRANTS

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

7. Substitutions: See Section 01 6000 - Product Requirements.

B. Wall Hydrants, HYD-1:
1. ASSE 1019; freeze resistant, self-draining type with chrome-plated wall plate hose thread spout, lockshield and removable key, and integral vacuum breaker.
2. Similar to Woodford Model 67.

2.06 BACKFLOW PREVENTERS

A. Manufacturers:
1. Conbraco Industries, Inc: www.apollovalves.com.
2. MIFAB, Inc: www.mifab.com/#sle.
3. Watts : www.watts.com.
4. Zurn Industries, LLC: www.zurn.com/#sle.
5. Substitutions: See Section 01 6000 - Product Requirements.

B. Reduced Pressure Backflow Preventer Assembly:
1. ASSE 1013; cast bronze body and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure, and non-threaded vent outlet.
2. Size: 3/4 to 2 inch assembly with threaded full port ball valves.
3. Accessories: Provide air gap fitting, lead-free Y-strainer, and test cocks.

2.07 DOUBLE CHECK-VALVE ASSEMBLIES

A. Manufacturers:
1. Conbraco Industries, Inc: www.apollovalves.com.
2. MIFAB, Inc: www.mifab.com/#sle.
3. Watts : www.watts.com.
4. Zurn Industries, LLC; 350AST: www.zurn.com/#sle.
5. Substitutions: See Section 01 6000 - Product Requirements.

B. Double Check Valve Assembly:
1. ASSE 1012; cast bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.
2. Size: 3/4 to 2 inch, NPS assembly with threaded full port ball valves.

2.08 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. Substitutions: See Section 01 6000 - Product Requirements.

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

2.09 SUMPS

A. Manufacturers:
1. Jay R. Smith Manufacturing Company: www.jrsmith.com/#sle.
2. Zurn Industries, LLC: www.zurn.com/#sle.
3. Hydromatic.
4. Weil.
5. Zoeller.
6. Liberty.
7. Substitutions: See Section 01 6000 - Product Requirements.

B. Glass fiber reinforced with required openings and drainage fittings.

C. Cover: 3/8 inch thick steel plate with gasket seal frames and anchor bolts.

2.10 SANITARY WASTE INTERCEPTORS

A. Manufacturers:
   1. Schier.
   2. Striem.
   3. ACO.
   4. Midwest Tank.
   5. MIFAB.
   6. Substitutions: See Section 01 6000 - Product Requirements.

B. Flammable Liquid Interceptor
   1. Striem Flammable Liquid Interceptor model FLI-275 shall be lifetime guaranteed and made in the USA of seamless, rotationally-molded polyethylene. Interceptor shall be furnished for above or below grade installation, with field adjustable riser system, and (2) vent connections. Interceptor capacity shall be 129 gallons of flammable liquids and 111 gallons of sediment. Covers shall provide water/gas-tight seal and have a maximum 16,000 lbs load capacity.
      a. 4" Plain End inlet/outlet, 3" Plain End vents.
      b. Capacities: Liquid: 262 gallons (35 cu.ft.); Sand: 111 gallons.
      c. Flammable liquid capacity: 129 gallons.
      d. Unit cast iron covers: 346 lbs.
      e. Maximum operating temperature 140 F continuous.
      f. Highway rated covers: 16,000 lb. capacity.
   2. Unit supplied with built-in adapter for up to 6" of adjustability. Provide additional risers as required for deeper burial depth.
   3. Cover placement allows full access to tank for proper maintenance.
   4. Outlet diptube is removable to inspect/clean piping.
   5. Provide neck extension as required to maintain 45 degree angle of vent to penetrate floor as indicated on drawings.
   6. Trap shall comply with all state and local codes.
   7. A water seal of 3-inches should be provided on the inlet to prevent any vapor gas into the building since the trench drains are not trapped.
   8. The interceptor outlet waste line must be provided with a full size cleanout

2.11 THERMOSTATIC MIXING VALVES

A. Manufacturers:
   1. Lawler Manufacturing Company, Inc.
   2. Leonard Valve Company
   3. Watts Regulator
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Valve: Rough bronze body, stainless steel or copper alloy bellows, integral temperature adjustment. All exposed mixing valves shall be chrome plated.

C. Accessories:
   1. Check valve on inlets.
   2. Volume control shut-off valve on outlet.
   3. Stem thermometer on outlet.
   4. Strainer stop checks on inlets.

2.12 DIGITAL MIXING VALVE STATION

A. Manufacturers:
   1. Powers
   2. Leonard Valve Company
   3. Armstrong
   4. PVI
   5. Substitutions: See Section 01 6000 - Product Requirements.

B. Furnish and install a digital - thermostatic water mixing valve station where shown on the drawings. Mixing valve shall have a capacity as scheduled.

C. Construction shall be lead free* design and in compliance with lead free laws. Digital water temperature control and monitoring system shall feature user interface panel. Temperature adjustment shall be made locally by user at the control module and shall not require a laptop computer or special software to initiate.
D. System shall control water temperature to +/- 2°F in accordance with ASSE 1017 and during periods of low and zero demand, and maintain a consistent system "idling" temperature to mitigate "temperature creep" without the use of a manual throttling device/balancing valve.
E. System shall digitally monitor and display the following without the use of an external module, laptop and special software that must be downloaded:
    1. Hot and cold-water inlet supply temperature in degrees F.
    2. Mixed outlet temperature and mixed outlet set point in degrees F.
    3. Mixed outlet flow in gallons per minute.
F. Control module shall integrate with building automation systems through Bacnet and Modbus protocols without the use of a separate module, and feature local and remote temperature alarms.
G. In the event of a power failure or loss of cold water, system will close the hot water supply via an internally charged capacitor and is not reliant on batteries which must be replaced. Actuator shall also feature a manual override which can be used to set mixed outlet temperature in the event of a power loss.
H. System shall be listed/approved to ASSE 1017, cUPC, NSF, CSA 24/UL873 and BTL (Bacnet Testing Laboratories), and should be mounted on a heavy-duty strut and factory-tested as a complete unit. System shall come with a standard 5-year limited warranty.
I. Refer to plumbing schematic for quantity and type of valves and accessories required as part of the mixing valve station.
J. Unit shall be similar to Powers IntelliStation.
K. Domestic water re-circulation pump shall be furnished with the package. Consult pump schedule for additional information.

2.13 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.
    3. Substitutions: See Section 01 6000 - Product Requirements.
B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.14 AIR VENTS

A. Manufacturers:
    1. Cash Acme, a brand of Reliance Worldwide Corporation: www.cashacme.com/#sle.
    2. ITT Bell & Gossett: www.bellgossett.com/#sle.
    3. Taco, Inc: www.taco-hvac.com/#sle.
    4. Substitutions: See Section 01 6000 - Product Requirements.
B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
C. Float Type:
    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.
D. Washer Type:
    1. Brass with hygroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

2.15 THERMOSTATIC RECIRCULATION VALVE (TRV)

A. Manufacturers:
    1. Therm-Omega-Tech, Inc., Circuit Solver™ TRV
    2. Substitutions: See Section 01 60 00 - Product Requirements.
B. Furnish and install as indicated on the plans, a thermostatically controlled recirculation valve (TRV) in the domestic hot water piping. TRV shall be self-contained and fully automatic without additional piping or control mechanisms.

1. TRV shall regulate the flow of recirculated domestic hot water based on water temperature entering the TRV regardless of system operating pressure.
    a. When fully closed the TRV shall bypass a minimum of 0.1 GPM hot water to maintain dynamic control of the recirculating loop.
    b. TRV shall be factory adjustable from 105 degree F (40.5 C) to 140 F (60 C) as required by project conditions.
        1) Fully open TRV shall modulate towards a minimum closed position upon sensing a water temperature above 3 F of set point.
    c. TRV shall be available in sizes ranging from ½ inch NPT to 2" NPT.
2. TRV assembly shall include line-size isolation ball valves, unions, and strainer.

C. TRV body and all internal components shall be constructed of stainless steel with major components constructed of type 303 stainless steel.
1. TRV sizes ½ inch through 2 inch shall be rated to 200 PSIG maximum working pressure.
    a. All TRV shall be standard tapered female thread, NPT.
2. All TRV shall be rated to 25 degree F (148.9 C) maximum working temperature.
3. TRV shall be ANSI/AWWA C800 compliant.
4. All TRV shall be NSF-61 certified for use in all domestic water systems.
5. Thermal actuator shall be spring operated and self cleaning, delivering closing thrust sufficient to keep orifice opening free of scale deposits.
    a. Thermal actuator shall be rated for a minimum of 200,000 cycles.

PART 3 EXECUTION

3.01 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. Pipe relief from backflow preventer to nearest drain.

H. Drain lines for roof hydrants shall be routed to nearest floor drain or mop basin.

I. 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.

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

K. 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.

L. Installation of TRV shall be made by qualified tradesmen. Install TRV in each domestic hot water return piping branch beyond last hot water device in that branch.
1. Lead free Isolation valves, union, and strainer are provided with the Circuit Solver assembly.
2. Provide suitable access panel as required in non-accessible ceilings and walls.

END OF SECTION

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SECTION 22 1500 - GENERAL-SERVICE COMPRESSED-AIR SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Rotary-screw air compressors.
B. Air dryers.
C. Air receivers.
D. Pipe and fittings.
E. Unions and couplings.
F. Pressure reducing stations.
G. Air outlets.

1.02 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.
B. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2020, with Addendum (2024).
C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2016.
D. ASME B31.1 - Power Piping; 2022.
E. ASME B31.3 - Process Piping; 2022, with Errata (2023).
F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2020.
G. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2019.
H. ISO 8573-1 - Compressed Air — Part 1: Contaminants and Purity Classes; 2010.
I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings
    1. Indicate piping system schematic with electrical characteristics and connection requirements.
    2. Product Data: Provide manufacturers catalog literature with capacity, weight, and electrical characteristics and connection requirements.
C. Closeout Documents:
    1. Manufacturer's Instructions: Indicate manufacturer's installation instructions, hoisting and setting requirements, starting procedures.
    2. Operation Data: Submit for air compressor, air receiver, and accessories, aftercooler, refrigerated air dryer, and pressure reducing station.
    3. Maintenance Data: Submit for air compressor, air receiver, and accessories, aftercooler, refrigerated air dryer, and pressure reducing station.
    4. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
D. Project Record Documents: Record actual locations of equipment and components. Modify shop drawings to indicate final locations.
E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
    1. See Section 01 6000 - Product Requirements for additional provisions.
    2. Extra Compressor Oil: One container, quart size.

1.04 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. Pressure Vessels: Comply with applicable code for installation of pressure vessels.
C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept air compressors, refrigerated air dryer on site in factory-fabricated containers with shipping skids and plastic pipe end protectors in place. Inspect for damage.

B. Protect piping and equipment from weather and construction traffic.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for reciprocating air compressors.

PART 2 PRODUCTS

2.01 ROTARY SCREW AIR COMPRESSORS

A. Manufacturers:
   1. Ingersoll Rand, Inc: www.ingersollrandproducts.com/#sle.
   2. Quincy Compressor, LLC: quincycompressor.com/#sle.
   3. Sullair, LLC: www.sullair.com/#sle.
   4. Atlas Copco

B. Type: Single stage, variable speed, direct-drive assembly.

C. Electrically-driven, air-cooled compressor unit; factory-assembled on inertia-base skid with heat exchanger(s), air intake filter(s), gage(s), sight glass(es), vibration isolators, thermostats, safeties, differential pressure oil pump, oil separator, moisture separator with drain trap, oil charging valve, and compressor bearings with ABMA STD 9, L10 life expectancy at 100,000 hours.

D. Receiver Accumulator Tank: 400 gal, base skid-mounted, vertical.

E. Thermostatic Water Valve: Factory supplied to match intended heat transfer performance requirements in terms of flow and pressure drop to maintain air supply demand.

F. Enclosure: Sound masking enclosure capable of reducing equipment generated noise down to 50 percent of generated loudness.

G. Controls:
   1. Indicators:
      a. Air temperature.
      b. Oil temperature.
      c. Air discharge pressure.
      d. Sump pressure.
      e. Air intake filter loading.
      f. Anti-recycle timer.
      g. Phase loss/reversal monitor.
      h. Solid-state overload relay for each compressor.
      i. Cycle counter and hour meter per compressor.
   2. Pushbutton or Handswitch: Start/stop and load/unload functions.
   3. Electronic Touchscreen Controller:
      a. Include digital versions of listed operators and indicators.
      b. Include built-in logic to track usage, optimize load, and diagnose system.
      c. BAS, SCADA, or other Integrated Automation Link: BACnet IP in accordance with ASHRAE Std 135.

H. Electrical:
   1. 20 hp at 460-VAC, 50 to 60 hz, TEFC motor, vfd controlled.
   2. Factory mount disconnect switch with terminal box with each circuit identified and spare to accommodate field-installed components. Ground each component to base of assembly.

2.02 AIR DRYERS

A. Type: Self-contained mechanical refrigeration type complete with heat exchanger, refrigeration compressor, automatic controls, moisture removal trap, internal wiring and piping, and full refrigerant charge.

B. Air Connections: Inlet and outlet connections at same level, factory insulated.

C. Heat Exchangers: Air to air and refrigerant to air coils. Provide heat exchangers with automatic control system to bypass refrigeration system on low or no-load condition.

D. Moisture Separator: Centrifugal type located at discharge of heat exchanger.

E. Refrigeration Unit: Hermetically sealed type to operate continuously to maintain specified 21 degrees F dew point. House unit in steel cabinet provided with access door and panel for maintenance and inspection.
F. Accessories: Air inlet temperature gauge, air inlet pressure gauge, on/off switch, high temperature light, power on light, refrigerant gauge, air outlet temperature gauge, air outlet pressure gauge.
G. Capacity:
    1. Discharge Air: _____ degrees F atmospheric dew point.
    2. Rated Air Flow: _____ cfm.
    3. Inlet Air Pressure: _____ psi.
    4. Pressure Differential from Inlet to Outlet: Maximum _____ psi.
H. Electrical Characteristics:
    1. ____ volts, single phase, 60 Hz.
    2. ____ amperes maximum fuse size.
    3. See Section 26 0583.
I. Motor: See Section 22 0513.
J. Controls: _____.
K. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
L. Disconnect Switch: Factory mount disconnect switch in control panel.

2.03 AIR RECEIVERS

A. Receiver: Vertical, built to ASME regulations for working pressure of 165 psi. Flange or screw inlet and outlet connections.
B. Fittings: Adjustable pressure regulator, safety valve, pressure gauge, drain cock, and automatic float actuated condensate trap.
C. Tank Finish: Shop primed.
D. Tank Size:
    1. Diameter: 36 inches.
    2. Height: 102 inches.
    3. Capacity: 400 gal.

2.04 PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, 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. Aluminum Tube: ASME B31.3, AW-6060 T51 or AW-6063 T5. ASME B31.3, ISO 8573-1
    1. Manufacturers:
        a. Applied System Technologies: appliedsystemtech.com/#sle.
        b. Parker Transair
        c. Prevost Corporation: www.prevostusa.com/#sle.
        d. Substitutions: See Section 01 6000 - Product Requirements.
    2. Powder coated and marked with internal and external dimensions, batch number and country of origin. Include markings at 0 and 90 degree drill positions for take-off connectors.
    3. Sizes: 5/8 inch, 1 inch, 1-1/2 inch, 2 inch, 2 1/2 inch 3 inch and 4 inch, all at 1/16 inch thickness. lengths of 9, 15 and 20 feet depending on diameter.
    4. Maximum Working Pressure: 230 psi. at -40F to 176F
    5. Fittings
        a. Fittings and Joints 1-1/2 inch and and smaller:
            1) Gripping ring with 1/2 turn release nut.
            2) Visual torque indicator.
            3) Lateral dismantling.
            4) Polymer with 30% fiberglass reingforcement.
            5) Gripping teeth of stainless steel Z10 CN 17-7E2
            6) Gasket Material: High nitrile rubber seal suitable for operating temperature range from minus 4 to 176 degrees F.

b. Fittings and Joints 2 and 2 1/2 inch:
    1) Threaded snap ring with threaded release nut.
    2) Lateral dismanatling.
    3) Black cataphoresis aluminum AS9U3 iwth snap ring manufactured in PA 6.6 or PA12; both with 50 percent fiberglass reinforcement.
c. Fittings and Joints 3 and 4 inch:
    1) 304 stainless conforming to ASTM A774.
    2) Clamshell and cartridge reusable assembly.
    3) Clamshell of Zink treated steel, nitrile NBR70, IRHD50 gaskets.

6. Drop Brackets, Wall Brackets and Fixing Clips:
    a. Optional drill hole drop backet with swan neck water retention.
    b. Male stud couplings and wall brackets of black nickel plated brass.
    c. Piping installed with polymer (30 percent fiberglass) fixing clips to match piping size. Clips to allow axial movement for expansion. Closure shall be quick close and secure with release nut.
7. Silicon Free: products guaranteed to be silicon free for applications such as painting.

2.05 UNIONS AND COUPLINGS

A. Unions:
    1. Ferrous Pipe: 150 psi malleable iron threaded unions.
    2. Copper Tube and Pipe: 150 psi bronze unions with soldered joints.
B. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
C. Flexible Connector: Neoprene with brass threaded connectors.

2.06 PRESSURE REDUCING STATIONS

A. Pressure Reducing Station: Consisting of automatic reducing valve and bypass, and low pressure side relief valve and gage. Provide oil separator where indicated.
B. Valve Capacity: Reduce pressure from 200 psi to 30 psi, adjustable upwards from reduced pressure.

2.07 AIR OUTLETS

A. Quick Connector: 3/8 inch brass, snap-on connector with self closing valve, Style A.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions.
B. Install compressor unit on concrete housekeeping pad. See Section 03 3000.
C. Make air cock and drain connection on horizontal casing.
D. Install line size gate valve and check valve on compressor discharge. See Section 22 0523.
E. Install replaceable cartridge type filter silencer of adequate capacity for each compressor.
F. Route condensate drains to nearest floor drain.
G. Install valved bypass around air dryer. Factory insulate inlet and outlet connections. See Section 22 0523.
H. Install valved drip connections at low points of piping system. See Section 22 0523.
I. Install takeoffs to outlets from top of main, with shut off valve after takeoff. Slope takeoff piping to outlets.
J. Install compressed air couplings, female quick connectors, and pressure gauges where outlets are indicated.
K. Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with plug.
L. Identify piping system and components. See Section 22 0553.
M. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote .

3.02 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Compressed Air Piping Leak Test: Prior to initial operation, clean and test compressed air piping in accordance with ASME B31.1.
C. Repair or replace compressed air piping as required to eliminate leaks, and retest to demonstrate compliance.
D. Cap and seal ends of piping when not connected to mechanical equipment.

END OF SECTION

SECTION 22 3000 - PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water heaters
B. Domestic Water Expansion tanks.
C. Reverse osmosis equipment.
D. In-line circulator pumps.
E. Submersible sump pumps.
F. Condensate removal pumps.

1.02 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023.

1.03 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. Indicate pump type, capacity, power requirements.
    3. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
    4. Provide electrical characteristics and connection requirements.
    5. Indicate heat exchanger dimensions, size of tappings, and performance data.
    6. 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. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
    3. Project Record Documents: Record actual locations of components.

1.04 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.
C. Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.
D. Performance: Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.05 DELIVERY, STORAGE, AND HANDLING

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

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
B. Manufacturer Warranty: Provide 5-year manufacturer warranty for domestic water heater. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 HOUSEKEEPING PAD FOR MACHINERY (BY MECHANICAL)

A. Housekeeping Pad Sub-bases shall be provided for all machinery such as RO/DI water skid and receiver tank. 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.

2.02 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.

2.03 WATER HEATERS

A. Manufacturers:
   1. PVI Industries: www.pvi.com
   2. Aerco International Inc.: aerco.com
   3. Diversified Heat Transfer, Inc.
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. **STEAM WATER HEATER**
   1. Water heater shall be furnished as scheduled on the drawings.
   2. Shell and Tube, Heating Fluid in U Tube Coil, Domestic Water double wall Heat Exchangers.
   3. Description: Tankless, packaged assembly of heat exchanger, controls and specialties for heating domestic water in shell with steam in coils or tubes.
   4. Shell Construction: 316L stainless steel (schedule 10s) water pressure vessel to be designed and constructed per ASME section VIII Div. 1, using low lead or lead free materials and rated at 200-psig/250F or higher design pressure/temperature. Shell cover to be constructed of 304L stainless steel.
      a. Configuration: Vertical.
      b. Shell Tappings: Factory fabricated of materials compatible with domestic water, heat exchanger shell. Attach tappings to shell before testing and labeling.
      c. Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire shell and nozzle except connections and controls.
   5. Heat Exchanger Coils: Copper single wall U tubes 5/8" diameter for heating fluid. Stainless steel 304L tube sheets and either commercial grade SS304 sheet metal or non-ferrous supporting baffles. Heat exchanger rated at 150PSIG/350F working pressure/temperature.
   6. Safety Control:
      a. Include automatic, over temperature limit switch which shall close the control valve on failure of control panel to close the control valve during over temperature condition.
      b. Include primary and secondary sound alarms functionality in the safety controls. Red light shall turn on when hot water temperature reaches primary alarm setting and alarm shall start sounding. In the next step, power supply to the control valve shall be interrupted causing it to close. If the water temperature continues to rise, it shall turn the secondary alarm on, which will then open the dump solenoid valve to release high temperature hot water to safe drain in order to protect the unit. Controls shall also include aquastat safety over the control panel system if it in case malfunctions.
   7. Relief Valves: ASME rated and stamped for combination temperature and pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input. Relief valve shall confirm ANSI Z21.22 with relieving capacity of at least as heat input.
   8. Miscellaneous Components for Steam Unit: Strainers, steam control valve, steam trap, valves pressure gauge, thermometer, and piping.
      a. Control valve shall have electronic actuator with fail close design (spring return) or loss of power. Electronic steam control shall have at least ANSI class IV shut off.
      b. Main condensate, steam inlet including strainer and hot water outlet piping assemblies' factory supplied for field installation.
      c. Vacuum breaker shall be factory installed on the steam side of heat exchanger.
      d. Gauges: Factory mounted pressure gauges on steam side and temperature gauge on shell side of heat exchanger.

9. Circulating Pump: UL/CUL listed, lead free bronze and stainless steel material construction, in-line pump. Include mechanical seals, 150-psig maximum working pressure rating, and 225 deg F continuous water temperature rating.
    a. Pump Control: Constant speed pump wired for continous operation and re-circulate water in the heat exchanger from hot water discharge to cold water inlet side.
10. Control panel shall be provided with the following associated features:
    a. Factory mounted to water heater shell. Provide manual disconnect switch for power supply to control panel.
    b. Control panel shall have password protection.
    c. Heater shall be supplied with solid-state control module with LCD backlit LED display and LED pilot lights to indicate on; off, primary high limit, and secondary high limit.
    d. Solid-state control module shall be provided with a field programmable digital electronic PID controller allowing the user to set operating and temperature limits on the display screen.
    e. Solid-state control module shall be supplied with dry contact closure outputs to indicate to building management system (BMS) the occurrence of power on, primary high temperature, and secondary high temperature.
    f. Control module shall be supplied with an on-off switch and shall be mounted in a NEMA 4 panel; all solenoids and limits shall be 24 VAC.
11. Building Management System Interface: The control panel either shall be capable of remote communications with the building management system to:
    a. Turn the heater on or off through a remote relay suitable for 24 VAC (1 amp).
    b. Remotely set the temperature of the heater using 4-20mA input signal.
    c. Remotely monitor the operating temperature.
    d. Remotely monitor over temperature alarm.
    e. Remotely monitor control valve opening percentage.
    f. For interface with BACnet TCP/IP, BACnet MS/TP, LonWorks, Metasys N2 and Modbus TCP/IP protocols; manufacturer supplied built-in translation communications gateway shall be utilized. Unit shall be able to communicate directly to Modbus RTU BMS without the need for this gateway.
12. Stand: Factory fabricated powder coated skid for floor mounting.

2.04 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.
    4. Substitutions: See Section 01 6000 - Product Requirements.
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; precharge to 12 psig.
D. See schedule for size.

2.05 REVERSE OSMOSIS EQUIPMENT

A. Manufacturers:
    1. Culligan International Company: www.culligan.com/#sle.
    2. Water Control Corp.
    3. Substitutions: See Section 01 6000 - Product Requirements.
B. Performance and Design Requirements:
    1. RO system shall be a fully operational factory assembled skid. Basis of design: Water Control Corporation R-2000-SA.
    2. The RO/DI water system shall be designed to circulate 12 GPM water supply to each distribution loop at 75 PSIG supply pressure, with a production rate of 2,000 GPD.
    3. The RO/DI water system shall be designed to the following make up water conditions (supplied from the domestic water system). Vendor shall be responsible for verification of make-up water characteristics:

a. Design Constraints:
1) Nominal Capacity: 2,000 gpd.
2) Recovery: 63 percent.
3) Motor hp: 3.
4) Operating Temperature Range: 40 - 85 degrees F.
5) Maximum Pump Operating Pressure: 145 psi.
6) Pump Flow: 30 gpm.
7) Dynamic Inlet Pressure:
(a) Maximum Pressure: 85 psi.
(b) Minimum Pressure: 45 psi.
8) Electrical Requirements: 460 VAC, 3 phase, 60 Hz.
9) Overall Size & Weight/Mass:
(a) Length: 216 inch, maximum.
(b) Width: 34 inch, maximum.
(c) Height: 82 inch, maximum.

C. Carbon Filter/Water Softeners:
1. Combination carbon filter/water softening system: Vertical pressure type ion exchanger system with regenerating equipment, complete with components required to insure proper operation.
2. The water filter/softening system shall consist of two resin tanks. During normal operation, one tank will be in service with the other in standby. Controller shall only allow one tank to regenerate at a time.
3. Resin tank: Fiberglass reinforced molded thermoplastic inner shell with dished heads, equipped with reinforced openings for control valve connections.
4. Internal distribution: Design underdrain system to uniformly collect softened water as well as distribute backwash laterally across entire bed:
a. Header-lateral construction with minimum of 2 plastic strainers per 1 SF of bed area.
b. Furnish gravel sub-fill only, not extending above strainers.
5. Upper distribution system: Header-lateral manifold type arranged for uniform distribution of both brine solution and raw waste, as well as collection of backwash:
a. Construct both upper and lower distributors of an approved non-corrosive material.
6. The filter shall be system for removal of residual chlorine and the reduction of nonpolar organics (TOC) from the city granular activated carbon (GAC) required in the pretreatment/makeup water inlet water. The activated carbon filter shall produce water having a residual chlorine concentration of less than 0.1 ppm when operated at the normal service conditions.
7. Ion exchange resin: High capacity sulfonated polystyrene type requiring no chemicals other than sodium chloride to obtain specified capacity.
8. Controls:
a. The softener tank shall be provided with a water volume initiated 5 cycle fully automatic regeneration, managed by a solid state electronic controller featuring:
1) Fully programmable cycle times.
2) Service and standby modes.
3) Water volume totalizer and flow rate displays.
4) System status indicator lights.
5) Provisions for additional auxiliary outputs.
9. Brine tank: Rigid, molded polyethylene:
a. Fresh make-up water shall flow downward through solid salt controlled by float valve in salt storage tank.
b. Provide automatic valve to control amount of brine draw.
c. Provide necessary valves, educator and piping.
d. Size: Large enough for a minimum of four (4) regenerations at full salting.
10. Provide water testing kit to make chemical tests necessary for controlling operation and adjustments of brine dosage.
11. Size and capacity as shown on drawings.

D. Reverse Osmosis (RO) Systems:
    1. Design Criteria: The reverse osmosis unit shall be designed to comply with the specified performance requirements.
    2. The reverse osmosis unit shall be supplied complete with membrane elements, pressure vessels, interconnecting piping and valves, instrumentation and controls, sample taps, pressure gauges, pump control, control panel, and support structure.
    3. Vessels/tubes:
        a. The RO vessels shall be PVC with easy-to-remove snap ring and removable end cap.
        b. Shall include double o-ring permeate seals.
    4. Membrane Elements:
        a. Membranes shall be Thin-film composite with FRP over-wrap, capable of 99% rejection at 100 psi.
        b. Furnish EPDM or Viton o-rings, gaskets, and seals. Furnish interconnectors and any other hardware required for a complete system.
    5. Controls: Solid state electronic controller.
        a. Flow, temperature, resistivity, and pressure transmitters and indicators shall be supplied as required for a complete and operating system
        b. Flow elements and indicators are required on the feed, product, recycle and reject streams. Includes percent recovery and rejection.
        c. Resistivity elements and indicators are required on the feed and product streams.
        d. Pressure transmitters and indicators are required on the pre-filter, pump discharge, product and reject streams.
        e. Provide controls interface compatible with the facility control system.
    6. Size and capacity as shown on drawings.
E. RO/DI Water Storage Tanks:
    1. A water storage tanks shall be provided to allow retention time for product water distribution for each system.
    2. Tanks shall be manufactured of linear, rotationally molded polyethylene with extra heavy wall construction.
    3. Fabrication:
        a. The tanks shall be vertical with cone bottoms and straight sides.
        b. Manways shall be provided with all necessary gaskets and covers.
        c. The final locations of nozzles and accessories shall be subject to change until shop drawing approval.
F. Repressurization Pumps:
    1. Each pump shall be an integral unit consisting of 316 stainless steel vertical multistage centrifugal pump and motor.
    2. Pump shall be non-contaminating and designed for the high purity service intended.
    3. Single external mechanical seal model shall have silicon carbide/silicon carbide surfaces, and stainless steel metallic parts. Elastomers shall be EPDM.
    4. All pumps shall be sized such that the impeller required at the given maximum flow and head is midrange of the impellers available in the casing provided. Motor horsepower shall be sized to prevent motor overloading at reduced system head.
    5. Operating point shall not be to the right of the maximum efficiency on the pump curve.
    6. Motor enclosures shall be TEFC. Motors shall be inverter duty rated, suitable for adjustable frequency drive operation, and 460 V, 60 Hz service.
G. Deionized (DI) Mixed Beds:
    1. Mixed bed ion exchange vessels shall be Service Deionization (SDI) type, with quick connect fittings on inlet and outlet to facilitate removal for off-site regeneration.
    2. Resin furnished shall be suitable for use in polish mixed bed deionizer application and for the intended application. The Vendor shall confirm with resin manufacturer the best vessel design to support the resin's unique characteristics.
    3. Equipment - vessels:

a. Each vessels volume shall be 0.5 cubic feet.
b. Vessels shall be filament wound FRP, ASME code rated at 150 psi working pressure.

H. Ultraviolet (UV) Sterilizers:
1. Design:
a. For Bacteria destruction the ultraviolet light wavelength shall be 254 nm.
b. The UV dosage shall be at least 40,000 mws/cm2 at 254 nm after 9,000 hours of operation time.
2. Gen
a. Single high-output lamp in a quartz tube with electrical connections at one end.
b. Single quartz sleeve to isolate the lamp tube from the product water.
c. UV monitor for continuous indication of UV lamp intensity.
d. An integral power-stepping function to maintain constant UV dosage during life of the UV lamp.
3. Construction:
a. Wetted surfaces of the UV sterilizer chamber and other components shall be 316L stainless steel.
b. Quartz sleeves shall be watertight to allow lamp changeout without draining the chamber.
c. Inlet and outlet piping connections to the UV sterilizers shall include a light trap, of at least one stainless steel 90 degree elbow and 2 feet of pipe shall be provided at each connection.
4. Power Panels:
a. The sterilizer power panels shall be controlled and powered, and at a minimum, provide local indication of the following:
1) Lamp ON/OFF status.
2) Lamp intensity.
3) Lamp run time.
4) Alarm status lights.
b. The UV sterilizers shall be configured such that, if power to the UV sterilizer is interrupted or lost, the UV sterilizers automatically restart once the power source is regained.

I. Final Filters:
1. High purity cartridge filter housings and elements for DI water final filtration.
2. Filter housings:
a. Housing and cap shall be constructed of polypropylene and shall include EPDM and Buna-N elastomers.
3. Filter elements:
a. 0.2 micron absolute rated beta 5000 (99.998%) retention efficiency.
b. High performance 100% pleated polypropylene construction with gradient, fixed pore structure.
c. Complies with FDA CFR criteria.

J. Control Panel:
1. System shall include an AssureIQ PLC controller with color touchscreen HMI. Control panel shall be a single point power connection distributing power to all the equipment mounted on the skid. AssureIQ Water Treatment Controller shall include individual component detail screens, multi-level user logins, electronic equipment maintenance reminders specific to individual components, BAS integration, data trending for inlet temperature, water quality (post RO and loop), pump discharge pressure, UV lamp intensity, and system alarms.
a. Single Point Power Connection: 460 Volt - 3 Phase. Power to:
1) Water Softener
2) Carbon Filter
3) Reverse Osmosis System
4) Repressurization Pump(s)
5) Ultraviolet Lamp(s)

2.06 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
5. Substitutions: See Section 01 6000 - Product Requirements.

B. Casing: Bronze, rated for 125 psig working pressure, with stainless steel rotor assembly.
C. Impeller: Composite or stainless steel. Polymer not allowed.
D. Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.
E. Seal: Carbon rotating against a stationary ceramic seat.
F. Drive: Flexible coupling or close coupled.

2.07 SUBMERSIBLE SUMP PUMPS

A. Manufacturers:
1. Goulds Pumps: www.goulds.com.
2. Zoeller Pump Company: www.zoeller.com.
3. Weil a WILO Company: www.weilpump.com
4. Substitutions: See Section 01 6000 - Product Requirements.

B. Type: Completely submersible, vertical, centrifugal.
C. Casing: Cast iron pump body and oil filled motor chamber.
D. Impeller: Cast iron; open non-clog, stainless steel shaft.
E. Bearings: Ball bearings.
F. Sump: Fiberglass basin with steel cover plate; 36 inches diameter, 36 inches deeper than lower inlet.
G. Accessories: Oil resistant 6 foot cord and plug with three-prong connector for connection to electric wiring system including grounding connector.
H. Sump pump shall be controlled using an integral float switch. Sump pump shall be furnished with a high water alarm including panel containing buzzer, light and silencing switch and float switch with 15'-0" power cable.
I. Controls: Integral diaphragm type level controls with separate liquid level control high level alarm.

2.08 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

3.01 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions required for applicable certifications.
B. Coordinate system, equipment, and piping work with applicable electrical, fuel, gas, vent, drain, and waste support interconnections as included or provided by other trades.
C. Domestic Water Storage Tanks:
1. Provide steel pipe support, independent of building structural framing members.
2. Clean and flush prior to delivery to site. Seal until pipe connections are made.

D. 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.

3.02 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements for additional requirements.

B. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface.

END OF SECTION

SECTION 22 4000 - PLUMBING FIXTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flush valve water closets.
B. Wall hung urinals.
C. Lavatories.
D. Wall-hung, solid surface, multistation lavatory units.
E. Wall-hung, multistation wash fountains.
F. Sinks.
G. Washing Stations.
H. Wash Fountains.
I. Mixing faucets/hose bibbs/hose reels
J. Eye and face wash fountains.
K. Bi-level, electric water coolers.
L. Mop sinks.
M. Emergency eye and face wash.
N. Emergency showers.

1.02 REFERENCE STANDARDS

A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
B. ASHRAE Std 18 - Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration.; 2013.
C. ASME A112.6.1M - Supports for Off-the-Floor Plumbing Fixtures for Public Use; 1997 (Reaffirmed 2017).
D. ASME A112.18.1 - Plumbing Supply Fittings; 2018, with Errata.
E. ASME A112.19.3 - Stainless Steel Plumbing Fixtures; 2017.
F. ASME A112.19.5 - Flush Valves and Spuds for Water Closets, Urinals, and Tanks; 2017.
G. ASSE 1014 - Performance Requirements for Backflow Prevention Devices for Hand-Held Showers; 2005.
H. ASSE 1070 - Performance Requirements for Water Temperature Limiting Devices; 2015.
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.

1.03 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.

1.04 QUALITY ASSURANCE

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

1.05 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.06 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.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for electric water cooler.

PART 2 PRODUCTS

2.01 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.

2.02 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.

2.03 ACCESSORIES

A. Carriers:
   1. See Fixtures

B. Stops
   1. 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.

2.04 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 or approved equal.

D. Lavatory Trim:
   1. American Standard, Kohler, T & S Brass, Chicago Faucet, Moen Commercial, Zurn Commercial, Delta, Acorn or approved equal.

E. Sink Trim:
   1. American Standard, Kohler, T & S Brass, Chicago Faucet, Moen Commercial, Zurn Commercial, Delta, Acorn or approved equal.

F. Seats:
   1. Bemis, Beneke, Church, Toto or approved equal.

G. Sinks:
   1. Elkay, Just or approved equal.

H. Washing Stations:
   1. WuduMate or approved equal.

I. Electric Water Coolers:
   1. Halsey Taylor, Elkay, Haws, Acorn, Oasis, Murdock or approved equal.

J. EW, EW/ES:
   1. Haws, Bradley, Encon, Stingray, Guardian, Speakman, Acorn (Murdock) or approved equal.

K. MB and Laundry Tubs:
   1. Fiat, Swan, Zurn Jonespec, Mustee, or approved equal.
L. Thermostatic Mixing Valves:
   1. Leonard, Lawler, Caleffi, Watts, Powers, or approved equal.
M. Trap Wraps:
   1. Brocar, Truebro, Plumberex, Lav-Guard, Proflo or an approved equal.

2.05 FIXTURES

A. NSF International certified sinks shall be used in all food prep areas.
B. L-1, Lavatory:
   1. Lavatory: Kohler Greenwich K-2032, Wall hung, Vitreous china, with back, anti-splash rim, arm support carrier.
   2. Trim: Sloan EAF-275-SOL-ITM, solar powered with battery backup, sensor activated, 0.5 GPM aerator, perforated strainer, 1-1/4" brass tailpiece, ASSE 1070 compliant internal mixing valve.
   3. Supplies: 3/8" angle supplies flexible tube riser, brass stops, chromed finish.
   4. Trap: 1-1/4" adjustable cast brass "P" trap.
   5. Size: 20 1/2" x 18 1/4"
   6. Arm Support Carrier: Smith #0700 or equal.
   7. Trap Guard: Truebro Lav Guard 2, P-trap and wall supplies insulation kit.
   8. Mounting: Refer to Architectural wall section for mounting height.
C. L-2, Lavatory:
   1. Lavatory: Kohler Pennington K-2196, Countertop, vitreous china.
   2. Trim: Sloan Optima EAF-150-ISM, battery operated, maximum flow aerator, 4" trim plate, perforated strainer, 1-1/4" brass tailpiece.
   3. Thermostatic Mixing Valve: Leonard 170D-LF-BRKT, ASSE 1070 Certified, bronze body point of use mixing valve with 3/8" inlet and outlet compression connections with cold water by-pass and mounting bracket.
   4. Supplies: 3/8" angle supplies with flexible tube risers, brass stops, chromed finish.
   5. Trap: 1-1/4" adjustable cast brass "P" trap.
   6. Trap Guard: Trap Guard: Truebro Lav Guard 2, P-trap and wall supplies insulation kit.
D. 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 Regal 111 SFSM-1.6, battery operated sensor flush valve, 1.6 gallons per flush.
   3. Seat: Bemis 1955C 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. For Bariatric water closets, provide heavy duty carrier rated for 500 lbs load. Heavier load carriers available, check fixture rating.
   6. Mounting: Refer to Architectural wall section for mounting height.
E. 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-1.0, battery operated sensor flush valve, 1.0 gallon flush.
   3. Carrier: Josam, Wade, Zurn, Watts or Smith.
   4. Mounting: Refer to Architectural wall section for mounting height.
F. WST-1, Washing Station:
   1. One piece, sanitary-grade reinforced acrylic, double module washing station with slip resistant bottom, stools, and seat support bracket and fittings.
   2. Washing Station: WuduMate, Model #Modular Double Carton
   3. Dimensions: 36.5" x 37" x 28.5"
   4. Furnish and install sensor activated taps with a thermostatic mixing valve for each washing station. Discharge temperature shall be set at 85°F. Provide integral stops and check valves for installation.

5. McAlpine Waste: ST90CP10USA-70.
6. Mounting: Refer to Architectural elevation.

G. S-1, Sink:
1. Sink: Elkay LR1919, Countertop, single compartment, type 304, 18-8 stainless steel, 18 gauge, self-rimming, back ledge.
2. Trap: Chrome plated cast brass "P" trap.
3. Supplies: 3/8" angle supplies with flexible tube riser, brass stops, chromed finish.
4. Size: 16" x 13-1/2" x 7-5/8"
5. Trap Guard: Truebro Lav Guard Model 102 E-Z, P-trap and wall supplies insulation kit.

H. S-2, Sink:
1. Sink: Elkay LR3319, Countertop, double compartment, type 304, 18-8 stainless steel, 18 gauge, self-rimming, back ledge.
2. Trap: Chrome plated cast brass "P" trap.
3. Supplies: 3/8" angle supplies with flexible tube riser, brass stops, chromed finish.
4. Size: 33" x 19-1/2" with two (2) 14" x 14" x 7-5/8" bowls
5. Trap Guard: Truebro Lav Guard Model 102 E-Z, P-trap and wall supplies insulation kit.

I. S-3, Sink:
1. Sink: Elkay SS8124L2, handicapped depth, floor mount, single compartment, centered drain outlet, 14 gauge type 304 stainless steel, 16 gauge stainless steel legs with adjustable feet, self-rimming, 8" backsplash.
2. Trim: Elkay LK940BP03T4S, centerset wall mount faucet 3" bucket hook, 4" wristblade handles, 1/2" offset inlets.
3. Trap: Chrome plated cast brass "P" trap.
4. Supplies: 3/8" angle supplies with flexible tube riser, brass stops, chromed finish.
5. Size: 49-1/2" x 27-1/2" with one (1) 24" x 24" x 14" bowl.

J. S-4, Sink:
1. Sink: Elkay WCL1923OSDC, wall hung, single compartment with eyewash combination, type 304, 18-8 stainless steel, 18 gauge, self-rimming, back ledge.
2. Trim: Speakman SEF-1800-CA-8TW, 4" wrist blade handles, 1/4 turn ceramic cartidges, lead free brass construction, dual aerated spray heads with flip top caps, 1.2 gpm faucet, 2.8 gpm @ 30 psi flow rate eyewash, eyewash is pull handle activated, faucet with integrated eyewash, provided with thermostatic mixing valve, ADA compliant.
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"x 23" x 4"

K. S-5, Sink:
1. Sink: Elkay SS8236L2, handicapped depth, floor mount, double compartment, centered drain outlet, 14 gauge type 304 stainless steel, 16 gauge stainless steel legs with adjustable feet, self-rimming, 8" backsplash.
2. Trim: Elkay LK940BP03T4S, centerset wall mount faucet 3" bucket hook, 4" wristblade handles, 1/2" offset inlets.
3. Trap: Chrome plated cast brass "P" trap.
4. Supplies: 3/8" angle supplies with flexible tube riser, brass stops, chromed finish.
5. Size: 61-1/2" x 27-1/2" x 14" with two (2) 24" x 24" x 14" bowls.

L. S-6, Sink:
1. Sink: Elkay LRAD221955, handicapped depth, countertop, single compartment, centered rear drain outlet, 18 gauge type 304 18-8 stainless steel, self-rimming, back ledge.
2. Trim: T&S Brass B-2731 with swing spout, single lever control, ceramic disk cartridge, aerator, 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: 22" x 19-1/2" with 18" x 14" x 5-3/8" bowl.

M. S-7, Sink:
   1. Sink: Elkay SS81362, handicapped depth, floor mount, single compartment, centered drain outlet, 14 gauge type 304 stainless steel, 16 gauge stainless steel legs with adjustable feet, self-rimming, 8" backsplash.
   2. Trim: Elkay LK940BP03T4S, centerset wall mount faucet 3" bucket hook, 4" wristblade handles, 1/2" offset inlets.
   3. Trap:
   4. Supplies: 3/8" angle supplies with flexible tube riser, brass stops, chromed finish.
   5. Size: 39" x 27-1/2" with one (1) 36" x 24" x 14" bowl.

N. S-8, Sink:
   1. Sink: Kohler Bannon K-6716, acid resisting enameled cast iron service sink with wall hanger, 3" adjustable trap standard, "U" type rim guard.
   2. Trim: Chicago Faucet #897-CP, ceramic disk cartridge, double service sink faucet with vacuum breaker, integral stops, hose end spout, wall brace, pail hook.
   3. Trap: Provide with sediment trap.
   4. Size: 24" x 20" x 10-1/2"
   5. Trap Guard: Truebro Lav Guard Model 102 E-Z, P-trap and wall supplies insulation kit.

O. S-9, Sink:
   1. Sink: Elkay ELUHAD211545PD, ADA compliant, undermount, single compartment, centered rear drain outlet, 18 gauge type 304 18-8 stainless steel, bottom only pads.
   2. Trim: Elkay LKGT1041, single hole, pull-out spray, single lever handle, 1.75 gpm, brass construction, ceramic disc valve.
   3. Trap: Chrome plated cast brass "P" trap.
   4. Supplies: 3/8" angle supplies with flexible tube riser, brass stops, chromed finish.
   5. Size: 23-1/2" x 18-1/4" x 4-3/8"
   6. Trap Guard: Truebro Lav Guard Model 102 E-Z, P-trap and wall supplies insulation kit.

P. S-10, Sink:
   1. Sink: Elkay LRAD191850, handicapped depth, drop-in countertop, single compartment, centered rear drain outlet, 18 gauge type 304 18-8 stainless steel, self-rimming, back ledge.
   2. Trim: T&S Brass B-2731 with swing spout, single lever control, ceramic disk cartridge, aerator, 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" x 18" x 5"
   6. Trap Guard: Truebro Lav Guard Model 102 E-Z, P-trap and wall supplies insulation kit.

Q. S-11, Sink:
   1. Sink: Elkay ELUHAD361845, handicapped depth, drop-in countertop, double compartment, centered rear drain outlet, 18 gauge type 304 18-8 stainless steel, self-rimming, back ledge.
   2. Trim: T&S Brass B-2731 with swing spout, single lever control, ceramic disk cartridge, aerator, 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: 35-3/4" x 18-1/2" x 4-3/8" with two (2) 16" x 16" x 4-3/8" bowls.
   6. Trap Guard: Truebro Lav Guard Model 102 E-Z, P-trap and wall supplies insulation kit.

R. SS-1, Service Sink:
   1. Acid resisting enameled cast iron service sink with wall hanger, 3" adjustable trap standard, "U" type rim guard.
   2. Sink: Kohler Bannon K-6716
   3. Supply: Chicago Faucet #897-CP, ceramic disk cartridge, double service sink faucet with vacuum breaker, integral stops, hose end spout, wall brace, pail hook.
   4. Size: 24"x 20"x 10½" deep.

S. WF-1, Wash Fountain:

1. Floor standing, thermostatic operated mixing valves, soap dispenser, foot operated, infra-red operated.
2. Fountain: Bradley #TDB3104, 54" semi-circular, wash fountain type.
3. Material: Precast marmorite. Color selected by Architect.

T. EWS-1, Electric Water Cooler with Bottle Filler
1. Murdock A172.8-UG-BF, 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.

U. EW/ES-1, Emergency Eye Wash/Shower Combination
1. All emergency eye/wash showers shall be packaged from the factory including all connecting piping between components. Field fabricated piping shall not be allowed.
2. Speakman SE-1255, ABS plastic shower head, stainless steel receptor with face and eye wash spray heads. Push action stay open ball valve, chrome pull rod for shower, stainless steel push flag and foot treadle for face/eye wash, 1-1/2" stainless steel standard with floor flange and wall brace, universal combination emergency eye-wash and shower sign. Provide P-trap for connection of face/eye wash bowl into waste system.
3. Furnish and install a Leonard Model EXL-800-LF, thermostatic mixing valve for each shower/eye wash. Controller shall be rough bronze finished thermostatic mixing valve with thermometer. Discharge temperature shall be set at 85°F. All exposed mixing valves shall be chrome plated. Provide stops and check valves for installation. Provide integral 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.

V. LF-1, Lab Faucet:
1. Chicago Faucet #LWV2, single water valve for wall or turret mount, laboratory nozzle with 10 serrations for laboratory hose, vandal proof 2-1/2" cross handle with button indexed 'CW', left-hand slow compression operating cartridge, rated operating pressure 20-125 psi, rated operating temperature 40F-140F.

W. LF-2, Lab Faucet:
1. Chicago Faucet #LWS1, deck-mounted single-inlet water faucet, 5-1/4" rigid/swing gooseneck spout, lab nozzle with 10 serrations for lab hose, vandal proof 2-1/2" cross handle with button indexed 'CW', left-hand slow compression operating cartridge, rated operating pressure 20-125 psi, rated operating temperature 40F-140F.

X. MB-1, Mop Basin:
1. Basin: Fiat Model MSB2424 molded stone, 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.

Y. MB-2, Mop Basin:
1. Basin: Zurn Model #Z1996-36 molded high density composite basin with integral molded, self-draining mop shelf, PVC drain body, stainless steel 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.
4. Size: 36" x 24" x 10".

Z. HEF-1, Hose End Faucets:
1. Equal to Chicago Faucet #952-CP, hose end sill faucet with atmospheric vacuum breaker. Chromium plated.

AA. HR-1, Hose Reel:
1. Hose reel shall be T&S brass Model B-7232-05 with 35 ft. of 3/8" hose and water gun. Mount hose reel 6'-6" above floor and furnish with 5' hose on inlet for connection to hose bibb or mixing faucet.

PART 3 EXECUTION

3.01 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.

3.02 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 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.

3.04 INTERFACE WITH WORK OF OTHER SECTIONS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.05 ADJUSTING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.06 CLEANING

A. Clean plumbing fixtures and equipment.

3.07 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

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SECTION 23 0060 - MECHANICAL DEMOLITION

PART 1 GENERAL

1.01 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.

1.02 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.

1.03 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

2.01 MATERIALS AND EQUIPMENT

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

PART 3 EXECUTION

3.01 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.

3.02 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.

3.03 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.

3.04 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.

3.05 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 0100 - MECHANICAL GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 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.

1.02 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".

1.03 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.

1.04 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.

1.05 PRIOR APPROVAL REQUESTS

A. Requests for substitution of materials and/or equipment other than those named in the specifications may be made to the Engineer. The request shall include complete information, test, etc. relating to quality, performance, and suitability. All requests shall be in the Engineers office not later than ten (10) days prior to the Bidding date. All approved requests shall be included in the project addenda.

1.06 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. 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 one 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).

1.07 MANUALS

A. In addition to catalog data and shop drawings submitted for review, this contractor shall furnish Systems Manuals (O&M's):

1. The Contractor Shall provide an electronic copy in Adobe PDF Portfolio format. The Portfolio shall contain:
    a. Approved Shop Drawings of all major mechanical components.
    b. Parts lists for the same components.
    c. Manufacturer's operating, maintenance, and cleaning instructions.
    d. List of materials recommended for maintenance.
    e. Factory startup reports.
    f. Valve tag list.
    g. Name and address of authorized service organization and parts depot.
    h. Chemical Treatment Analysis Reports for heating & cooling systems.
    i. Radiographic Testing Reports of welded pipe with picture of weld & location plan showing physical location of where test was performed.
    j. 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".
    k. A description of normal operating conditions for the system and its components.
    l. A description of common symptoms of a malfunctioning system and likely causes.
    m. Warranty letter from the automatic temperature controls contractor indicating the warranty period for their portion of the work.
    n. Signed owner instruction forms for all items specified as requiring owners' instruction.
2. File volume sizes should be restricted to 30Mb. Multiple volumes may be required.
3. The Systems manual shall have an electronic index and be broken up by individual systems such as "heating", "shop exhaust", "kitchen ventilation and exhaust", "chilled water", "administration ventilation".
4. 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.
5. All major pieces of equipment shall be referenced with the equipment supplier's name, address and phone number shall be provided.
6. In addition to the electronic version, the Contractor shall prepare two (2) hard copies of all systems manual. Information shall be submitted neatly folded to approximately 8-1/2" x 11" size and shall be bound in indexed looseleaf 3-ring binders of adequate size to contain the material. Upon completion of these portfolios, the Contractor shall turn over the same to the Engineer for approval and delivery to the Owner.
7. 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.

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

1.08 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. Refrigeration equipment including but not limited to air cooled chillers and dry coolers shall not be less than eight (8) man hours.
    2. Heat transfer systems including but not limited to circulating pumps, condensate pumps, heat exchangers, in-floor heating/melting systems, and terminal heating and or cooling units shall not be less than eight (8) man hours.
    3. Ventilation systems including but not limited to make-up air units, carbon monoxide controls, nitrogen dioxide controls, packaged rooftop units, packaged air handlers, air flow measuring stations, centrifugal fans, exhaust fans, energy recovery units, terminal air units, vehicle exhaust systems, and dust collection systems shall not be less than eight (8) man hours.
    4. Automatic temperature control systems including all components of the system shall be not less than sixteen (16) man hours.

1.09 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.

1.10 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.

1.11 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.

1.12 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.

1.13 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.

1.14 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.

1.15 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.

1.16 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.

1.17 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.

1.18 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.

1.19 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

2.01 NOT USED

PART 3 EXECUTION

3.01 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**
Refrigeration						
Heat Transfer						
Ventilation						
Temperature Control						

3.02 LIST OF CONSTRUCTION CLOSEOUT DOCUMENTS

SECTION	DOCUMENT	DATE/INITIALS	APPROVED
23 01 00	Record drawings - HVAC & Controls		
23 01 00	O&M Manuals - HVAC & Controls		
23 01 00	Owner instruction - HVAC & Controls		
23 05 53	Valve, pipe, duct, equipment labeling & valve schedule		
23 05 93	Submit duct leakage test results		
23 05 93	Submit test & balance report		
23 07 13	Verify ductwork above ceiling fully insulated		
23 07 19	Verify piping above ceiling fully insulated		
23 09 23	Verify thermostats are programmed and calibrated		
23 21 13	AHU coil vent/drains piped to exterior of AHU casing		
23 50 00	Insulate all valves, strainers, unions		
23 21 13/23 22 13	Provide valid welding certification for welders		
23 21 23/23 22 13	Submit radiographic test results for aboveground or underground welds including image, reading, report and location		
23 21 23	Inline pumps above 5 HP, factory start-up technician sign-off		
23 21 23	Base mounted pumps, factory start-up/alignment technician sign-off		
23 25 00	Provide heating/cooling system initial fill water analysis		
23 25 00	Provide engineer with water analysis upon completion of filling system		
23 25 00	Provide independent lab results of water testing and glycol concentration		
23 25 00	Document glycol percentage before system turn-over		
23 25 00	Document glycol test 1 year post fill and replenish to specified percentage		

23 25 00	Provide documentation of extra sidestream filter cartridges turned over to owner		
23 34 23	Carbon monoxide control systems started by factory technician - sign-off		
23 64 23/23 64 26	Chiller factory start up technician sign-off		
Div. 23	Provide wall escutcheon on pipe penetrations through walls and floors		
Div. 23	Submit all factory/contractor start-up reports		
Div. 23	Ensure all holes existing and new have been patched, all duct/pipe penetrations have been draft stopped or fire caulked and painted to match		
Div. 23	Provide documentation that extra AHU filters specified have been turned over		
Div. 23	Turn over all extra belts specified		
Div. 23	Clean all mechanical areas of debris, wipe down all fixtures and equipment. Remove all extra material and garbage from site		
Div. 23	All air handling equipment specified to have factory start-up, technician sign here		

END OF SECTION

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SECTION 23 0150 - MECHANICAL MATERIALS & METHODS

PART 1 GENERAL

1.01 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.

1.02 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.

1.03 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

2.01 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 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.

H. 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.

I. 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.

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

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

2.02 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

3.01 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.

3.02 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.

3.03 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.

3.04 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.

3.05 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.

3.06 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

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SECTION 23 0513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

A. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.
B. Section 26 2913 - Enclosed Controllers.

1.03 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.
B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2004.
C. NEMA MG 1 - Motors and Generators; 2017.
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 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.

1.05 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.

1.06 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.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 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

2.02 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 1 limits for insulation class, service factor, and motor enclosure 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.

2.03 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, and direct drive axial fans: Totally enclosed type.
D. Motors located in outdoors: Totally enclosed weatherproof epoxy-treated type.
E. Motors driven by Variable Frequency Drives shall in be listed for the application.

2.04 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.

2.05 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.

2.06 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.

2.07 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 1 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 1.
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.

2.08 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

3.01 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

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SECTION 23 0516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flexible pipe connectors.
B. Expansion joints and compensators.
C. Pipe loops, offsets, and swing joints.

1.02 REFERENCE STANDARDS

A. FM (AG) - FM Approval Guide; current edition.
B. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.

1.03 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
    1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
    2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
C. Closeout Documents:
    1. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
    2. Maintenance Data: Include adjustment instructions.

PART 2 PRODUCTS

2.01 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

A. Manufacturers:
    1. The Metraflex Company: www.metraflex.com/#sle.
    2. Substitutions: See Section 01 6000 - Product Requirements.
B. Inner Hose: Stainless Steel.
C. Exterior Sleeve: Single braided, stainless steel.
D. Pressure Rating: 125 psi up to 12 inch.
E. Size: Use pipe sized units.
F. Maximum offset: 3/4 inch on each side of installed center line.

2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

A. Manufacturers:
    1. Adsco
    2. EFP
    3. Flexonics
    4. The Metraflex Company: www.metraflex.com/#sle.
    5. Substitutions: See Section 01 6000 - Product Requirements.
B. Inner Hose: Bronze.
C. Exterior Sleeve: Braided bronze.
D. Pressure Rating: 125 psi up to 2 inch.
E. Size: Use pipe sized units.
F. Maximum offset: 3/4 inch on each side of installed center line.
G. Application: Copper piping.

2.03 EXPANSION JOINTS - COPPER BELLOWS TYPE

A. Fin Radiation, pipe 3/4 through 2 inch.
    1. Expansion compensators shall be packless, low pressure type with phosphor deoxidized copper bellows, suitable for a water working pressure of up to 60 psig. and a maximum temperature of 250□ F. Compensators shall be furnished with sweat ends, and shall have a total traverse of 3/4".

2.04 EXPANSION JOINTS - STAINLESS STEEL BELLOWS TYPE

A. Manufacturers:
    1. Adsco

2. EFP
3. Flexonics
4. The Metraflex Company: www.metraflex.com/#sle.
5. Substitutions: See Section 01 6000 - Product Requirements.

B. Steam Pipe 2 1/2 inches and larger:
1. Expansion joints shall be corrugated (single) type, self equalizing with stainless steel bellows. Expansion joints shall be furnished with 150 pound ASA Steel flanges or with pipe nipple ends beveled for welding as required. Joints shall have a total axial traverse of not less than (three) inches.

C. Hot Water, Steam or Condensate up to 2 1/2 inches:
1. Expansion joints shall be packless, high pressure, internally guided type with stainless steel bellows, suitable for 125 psig. steam working pressure or 150 psig water working pressure. Expansion joints shall be furnished with screwed male pipe ends, flanged ends, screwed union ends, or butt weld ends as required. Joints shall have a total traverse of not less than two inches.

2.05 EXPANSION JOINTS - TWO-PLY BRONZE BELLOWS TYPE

A. Manufacturers:
1. Substitutions: See Section 01 6000 - Product Requirements.

B. Construction: Bronze with anti-torque device, limit stops, internal guides.
C. Pressure Rating: 125 psi and 400 degrees F.
D. Maximum Compression: 1-3/4 inches.
E. Maximum Extension: 1/4 inch.
F. Joint: As specified for pipe joints.
G. Size: Use pipe sized units.
H. Application: Copper piping.

2.06 ACCESSORIES

A. Pipe Alignment Guides:
1. Manufacturers:
a. Substitutions: See Section 01 6000 - Product Requirements.
2. Pipe guides shall be installed where required for proper installation of expansion loops and expansion joints.
3. Pipe guides shall not be used as pipe supports.
4. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.

B. Pipe Anchors:
1. Piping shall be securely anchored where indicated on drawings or where required for proper installation and to force the pipe expansion in the proper direction. Anchors shall be suitable for the location of installation and shall be designed to withstand not less than five times the anchor load. Vertical pipes shall be anchored by means of clamps welded around pipes and secured to wall or floor construction.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Provide expansion loops on piping runs over 75 feet and over 170 degrees. Include anchors and guides. Submit expansion and loop sizing calculations.
C. Provide swing joints and offset's at takeoffs from mains.
D. Do not terminate long runs tight to walls, restricting pipe movement.
E. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
F. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
G. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
H. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

I. Substitute grooved piping for vibration isolated equipment instead of flexible connectors. Grooved piping need not be anchored.

END OF SECTION

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SECTION 23 0517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe sleeves.

B. Pipe-sleeve seals.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 09 9113 - Exterior Painting: Preparation and painting of exterior piping systems.

C. Section 09 9123 - Interior Painting: Preparation and painting of interior piping systems.

D. Section 23 0716 - HVAC Equipment Insulation.

E. Section 23 0719 - HVAC Piping Insulation.

1.03 REFERENCE STANDARDS

A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2022a.

B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).

1.04 SUBMITTALS

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

B. Shop Drawings:

1. Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.05 QUALITY ASSURANCE

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

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.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 PIPE SLEEVES

A. Manufacturers:

1. Flexicraft Industries; Pipe Wall Sleeve: www.flexicraft.com/#sle.
2. Metraflex; Wall Sleeve: www.metraflex.com
3. GPT Industries; Wall Sleeves: www.gptindustries.com
4. Substitutions: See Section 01 6000 - Product Requirements.

B. Vertical Piping:

1. Sleeve Length: 2 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.

C. Plastic or Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.

D. Pipe Passing Through Below Grade Exterior Walls:

1. Zinc coated or cast iron pipe.
2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.

E. Pipe Passing Through Concrete Beam Flanges, except where Brass Pipe Sleeves are Specified:

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

F. Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:

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

G. Clearances:
    1. Provide allowance for insulated piping.
    2. Wall, Floor, Partitions, and Beam Flanges: 1 inch greater than external pipe diameter.
    3. All Rated Openings: Caulked tight with fire stopping material in compliance with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

2.02 PIPE-SLEEVE SEALS

A. Manufacturers:
    1. GPT Industries; Link-Seal: www.gptindustries.com/en/products/link-seal
    2. Flexicraft Industries; PipeSeal: www.flexicraft.com/#sle.
    3. Metraflex; MetraSeal: www.metraflex.com/
    4. Substitutions: See Section 01 6000 - Product Requirements.
B. Modular Mechanical Sleeve-Seal:
    1. Elastomer-based interlocking links continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
    2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
    3. Size and select seal component materials in accordance with service requirements.
    4. Glass-reinforced plastic pressure end plates.

PART 3 EXECUTION

3.01 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.

3.02 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
B. Install piping to conserve building space, to not interfere with use of space and other work.
C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
D. Structural Considerations:
    1. Do not penetrate building structural members unless indicated.
E. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
    1. Underground Piping: Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.
    2. Aboveground Piping:
        a. Pack solid using mineral fiber in compliance 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.
    3. All Rated Openings: Caulk tight with fire stopping material in compliance with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.
F. Manufactured Sleeve-Seal Systems:
    1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
    2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
    3. Locate piping in center of sleeve or penetration.
    4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
    5. Tighten bolting for a water-tight seal.
    6. Install in accordance with manufacturer's recommendations.
G. 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.

3.03 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

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SECTION 23 0519 - METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Flow meters.
B. Pressure gauges and pressure gauge taps.
C. Thermometers and thermometer wells.

1.02 RELATED REQUIREMENTS

A. Section 23 0923 - Direct-Digital Control System for HVAC.
B. Section 23 0943 - Pneumatic Control System for HVAC.
C. Section 23 2113 - Hydronic Piping.
D. Section 23 2213 - Steam and Condensate Heating Piping.

1.03 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.
B. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi; 2004 (Reaffirmed 2017).
C. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

1.04 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

2.01 LIQUID FLOW METERS (HOT WATER AND CHILLED WATER SYSTEMS)

A. Manufacturers:
    1. Flow Design
    2. Gerand
    3. Griswold
    4. K.G.
    5. Nexus
    6. Tour & Andersson
    7. Substitutions: See Section 01 6000 - Product Requirements.
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. 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).
    2. Flow meter fittings on lines 1/2", 3/4" and 1" size, up to 7 gpm may be calibrated orifice type with integral tamperproof valve. Flow fitting meter shall be provided with quick connect couplings.
    3. 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.

2.02 PRESSURE GAUGES

A. Manufacturers:
    1. Trerice.
    2. Weksler.
    3. Weiss.
    4. Winter.
    5. Substitutions: See Section 01 6000 - Product Requirements.

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: Steel with brass bourdon tube.
   2. Size: 4-1/2 inch diameter.
   3. Mid-Scale Accuracy: One percent.
   4. Scale: Psi.

2.03 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.

2.04 STEM TYPE THERMOMETERS

A. Manufacturers:
   1. Trerice
   2. Weiss
   3. Weksler Glass Thermometer Corp: www.wekslerglass.com.
   4. WIKA
   5. Winters
   6. Substitutions: See Section 01 6000 - Product Requirements.
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.

2.05 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.06 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

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Venturi flow meters
   1. Flow meter fittings used on lines above 7 gpm shall be of the Venturi Type. Fittings shall be installed in return lines where indicated on the drawing. Fittings shall be pipe size. Flow fitting meter tappings shall be provided with shut-off cocks and quick connect couplings.
   2. Ball valve indicators in sizes larger than 1 inch may be used the piping for multiple coil installations only.
   3. Valves shall be provided with stem extension and port extensions as required for insulation thickness applied.
C. Provide one pressure gage per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gage.
D. 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.
E. All pressure gauges on water systems shall be installed with a 1/4" isolation ball valve and filter type pressure snubber.
F. All pressure gauges on steam systems shall be installed with a 1/4" isolation ball valve and pigtail siphon filled with water.
G. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
H. Provide instruments with scale ranges selected according to service with largest appropriate scale.

I. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
J. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
K. Locate test plugs adjacent thermometers and thermometer sockets.

END OF SECTION

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SECTION 23 0523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Globe valves.
B. Ball valves.
C. Butterfly valves.
D. Check valves.
E. Gate valves.
F. Chainwheels.

1.02 RELATED REQUIREMENTS

A. Section 08 3100 - Access Doors and Panels.
B. Section 23 0553 - Identification for HVAC Piping and Equipment.
C. Section 23 2113 - Hydronic Piping.
D. Section 23 2213 - Steam and Condensate Heating Piping.

1.03 ABBREVIATIONS AND ACRONYMS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Non-rising stem.
E. OS&Y: Outside screw and yoke.
F. PTFE: Polytetrafluoroethylene.
G. RS: Rising stem.
H. TFE: Tetrafluoroethylene.
I. WOG: Water, oil, and gas.

1.04 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; 2020.
E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2018.
F. ASME B31.9 - Building Services Piping; 2020.
G. ASME BPVC-IX - Qualification Standard for Welding, Brazing, and Fuzing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators - Welding Brazing and Fusing Qualifications; 2019.
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 A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).
K. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).
L. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings; 2017.
M. AWWA C606 - Grooved and Shouldered Joints; 2015.
N. MSS SP-45 - Drain and Bypass Connections; 2020.
O. MSS SP-67 - Butterfly Valves; 2017, with Errata.
P. MSS SP-68 - High Pressure Butterfly Valves with Offset Design; 2021.
Q. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends; 2011.
R. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.
S. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service; 2010a.
T. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
U. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends; 2011.
V. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010.
W. MSS SP-125 - Check Valves: Gray Iron and Ductile Iron, In-Line, Spring-Loaded, Center-Guided; 2018.

1.05 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.

1.06 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.

1.07 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

2.01 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. Throttling (Steam): Globe.
3. Isolation (Shutoff): Butterfly, Gate, and Ball.
4. Swing Check (Pump Outlet):
   a. Size 2 inch and Smaller: Bronze with bronze disc.
   b. 2-1/2 NPS and Larger: Iron with lever and weight, lever and spring, center-guided metal, or center-guided with resilient seat.
5. 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. Chilled Water Valves:

1. 2 NPS and Smaller, Bronze Valves:
   a. Threaded ends.
   b. Ball: Full port, two piece, brass trim.
   c. Swing Check: Bronze disc, Class 125.
2. Size 2-1/2 inch and Larger, Iron Valves:
   a. Ball: 2-1/2 NPS to 10 inch, Class 150.
   b. Single-Flange Butterfly: 2-1/2 inch to 12 inch, aluminum-bronze disc, EPDM seat, 200 CWP.
   c. Single-Flange Butterfly: 14 inch to 24 inch, aluminum-bronze disc, EPDM seat, 150 CWP.
   d. Grooved-End Butterfly: 2-1/2 inch to 12 inch, 175 CWP.
   e. Swing Check: Metal seats, Class 125.
   f. Swing Check with Closure Control: 2-1/2 inch to 12 inch, lever and spring, Class 125.
   g. Grooved-End Check: 3 inch to 12 inch, 300 CWP.
   h. Plate-Type Check: Single plate, metal seat, Class 125.
   i. Gate: NRS, Class 125.

G. Heating Hot Water Valves:

1. 2 NPS and Smaller, Bronze Valves:
   a. Threaded 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 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. Single-Flange Butterfly: 14 inch to 24 inch, aluminum-bronze disc, EPDM seat, 150 CWP.
   e. Grooved-End Butterfly: 2-1/2 inch to 12 inch, 175 CWP.
   f. Swing Check: Metal seats, Class 125.
   g. Swing Check: 2-1/2 inch to 12 inch, lever and spring closure control, Class 125.
   h. Grooved-End Swing Check: 3 inch to 12 inch, 300 CWP.
   i. Plate-Type Check: Single plate, metal seat, Class 125 .
   j. Gate: NRS, Class 125.

H. Low Pressure Steam Valves for Pressures of 15 psi or Less:

1. 2 NPS and Smaller, Bronze and carbon steel Valves:
   a. Ball: Full port, two piece, stainless steel trim.
   b. Swing Check: Bronze disc, Class 125.
   c. Gate: NRS, Class 125.
   d. Globe: Bronze disc, Class 125.
2. Size 2-1/2 inch and Larger, Iron Valves:
   a. 2-1/2 NPS to 4 NPS: Flanged ends.
   b. Swing Check: 2-1/2 inch to 12 inch, lever and spring closure. control, Class 125.
   c. Gate: NRS, Class 125.
   d. Globe: 2-1/2 inch to 12 inch: Class 125.

I. High Pressure Steam Valves (Greater than 15 PSIG):

1. 2 NPS and Smaller, Carbon Steel Valves:
   a. Gate: RS, Class 150.
   b. Globe: Bronze disc, Class 150.
2. Size 2-1/2 inch and Larger, Iron Valves:
   a. 2-1/2 NPS to 4 NPS: Flanged ends.

b. Swing Check: 2-1/2 inch to 12 inch, lever and spring closure control, Class 125.
c. Gate: OSY, Class 150.
d. Globe: 2-1/2 NPS to 12 NPS, Class 150.

J. Steam-Condensate Valves:
1. 2 NPS and Smaller, Bronze and Carbon Steel Valves:
a. Gate: NRS and RS, Class 150.
b. Ball: Full port, three piece, stainless steel trim.
c. Globe: Bronze disc, Class 150.
2. Size 2-1/2 inch and Larger, Iron Valves:
a. Provide 2-1/2 NPS to 4 NPS with flanged ends.
b. Swing Check: Lever and weight closure control, Class 125.
c. Gate: OSY, Class 150.
d. Globe: 2-1/2 NPS to 12 NPS, Class 150.

2.02 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. Valve Manufacturers (unless otherwise noted)
1. Apollo Valves
2. NIBCO
3. Milwaukee
4. Hammond
5. Jomar
6. Watts
7. Substitutions: See Section 01 6000 - Product Requirements.

2.03 BRONZE, GLOBE VALVES

A. CWP Rating: Class 125: 200 psi:
   1. Comply with MSS SP-80, Type 1.
   2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
   3. Ends: Threaded or solder joint.
   4. Packing: Asbestos free.
      a. Handwheel: Malleable iron.

2.04 IRON, GLOBE VALVES

A. CWP Ratings: Class 125: 200 psi and Class 250: 500 psi:
   1. Comply with MSS SP-85, Type I.
   2. Body: Gray iron; ASTM A126, with bolted bonnet.
   3. Ends: Flanged.
   4. Trim: Bronze.
   5. Packing and Gasket: Asbestos free.
   6. Operator: Handwheel or chainwheel.

2.05 BRASS, BALL VALVES

A. Two Piece, Full Port with Stainless Steel Trim:
   1. Comply with MSS SP-110.
   2. SWP Rating: 150 psi.
   3. CWP Rating: 600 psi.
   4. Body: Forged brass.
   5. Seats: PTFE or TFE.
   6. Stem: Stainless Steel.
   7. Ball: Chrome-plated brass.

2.06 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. SWP Rating: 150 psi.
   3. CWP Rating: 600 psi.
   4. Body: Forged bronze.
   5. End Connections: Pipe thread.
   6. Seats: PTFE.
   7. Stem: Bronze or brass.
   8. Ball: Chrome plated brass.

2.07 CARBON STEEL, BALL VALVES

A. Class 300, Full Port, Stainless Steel Trim:
   1. Comply with MSS SP-72.
   2. CWP Rating: 720 psi.
   3. Body: Carbon steel, ASTM A216/A216M, Type WCB.
   4. Seats: PTFE.
   5. Stem: Stainless steel.
   6. Ball: Stainless steel, vented.

2.08 IRON, BALL VALVES

A. Split Body, Full Port:
   1. Comply with MSS SP-72.
   2. CWP Rating: 200 psi.
   3. Body: ASTM A126, gray iron.
   4. Ends: Flanged.
   5. Seats: PTFE.

6. Stem: Stainless steel.
7. Ball: Stainless steel.

2.09 IRON, SINGLE FLANGE BUTTERFLY VALVES

A. Lug Style; Bidirectional dead-end service without use of downstream flange:
1. Comply with MSS SP-67, Type I.
2. Lug Style, CWP Ratings:
a. Sizes 2 to 12 inch: 150 psi.
b. Sizes 14 to 24 inch: 100 psi.
c. Vacuum Service: Down to 29.9 in-Hg.
3. Body: Ductile iron.
4. Stem: One or two-piece stainless steel.
5. Seat: EPDM.
6. Disc: Aluminum-bronze.

2.10 HIGH-PERFORMANCE, SINGLE FLANGE BUTTERFLY VALVES

A. Lug type; Bidirectional dead end service without downstream flange:
1. Comply with MSS SP-68.
2. Class 150: CWP Rating: 285 psig and Class 300: CWP Rating: 720 psig at 100 degrees F.
3. Body: Carbon steel or stainless steel.
4. Seat: Metal or reinforced PTFE.
5. Offset stem: Stainless steel.
6. Disc: Carbon steel

2.11 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.

2.12 BRONZE, SWING CHECK VALVES

A. Class 125: CWP Rating: 200 psig (1380 kPa) and Class 150: CWP Rating: 300 psig (2070 kPa).
1. Comply with MSS SP-80, Type 3.
2. Body Design: Horizontal flow.
3. Body Material: Bronze, ASTM B62.
4. Ends: Threaded.
5. Disc: Bronze.

2.13 IRON, FLANGED END SWING CHECK VALVES

A. Class 125: CWP Rating: 150 psig (1035 kPa) with Metal Seats and Class 250: CWP Rating: 300 psig (2070 kPa) with Metal Seats.
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.

2.14 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Globe:
1. Comply with MSS SP-125.
2. Sizes 2-1/2 to 12 inch: CWP Rating; 200 psi.
3. Sizes 14 to 24 inch: CWP Rating; 150 psi.

4. Body Material: ASTM A126, gray iron.
5. Style: Spring loaded.
6. Ends: Flanged.
7. Resilient Seat: EPDM or NBR.

B. Class 150, Globe:
1. Comply with MSS SP-125.
2. Sizes 2-1/2 to 12 inch: CWP Rating; 300 psi.
3. Sizes 14 to 24 inch: CWP Rating; 250 psi.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Spring loaded.
6. Ends: Flanged.
7. Resilient Seat: EPDM or NBR.

C. Class 250, Globe:
1. Comply with MSS SP-125.
2. Sizes 2-1/2 to 12 inch: CWP Rating; 400 psi.
3. Sizes 14 to 24 inch: CWP Rating; 300 psi.
4. Body Material: ASTM A126, gray iron.
5. Style: Spring loaded.
6. Ends: Flanged.
7. Metal Seat: Bronze.

D. Class 300, Globe:
1. Comply with MSS SP-125.
2. Sizes 2-1/2 to 12 inch: CWP Rating; 500 psi.
3. Sizes 14 to 24 inch: CWP Rating; 400 psi.
4. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
5. Style: Spring loaded.
6. Ends: Flanged.
7. Metal Seat: Bronze.

2.15 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.

B. Class 150 Dual-Plate:
1. Comply with API STD 594.
2. Sizes 2-1/2 to 12 inch: CWP Rating; 300 psi.
3. Sizes 14 to 24 inch: CWP Rating; 250 psi.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
6. Metal Seat: Bronze.

C. Class 250 Dual-Plate:
1. Comply with API STD 594.
2. Sizes 2-1/2 to 12 inch: CWP Rating; 400 psi.
3. Sizes 14 to 24 inch: CWP Rating; 300 psi.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A126, gray iron.
6. Metal Seat: Bronze.

D. Class 300 Dual-Plate:
1. Comply with API STD 594.

2. Sizes 2-1/2 to 12 inch: CWP Rating; 500 psi.
3. Sizes 14 to 24 inch: CWP Rating; 400 psi.
4. Body Design: Wafer, spring-loaded plates.
5. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
6. Metal Seat: Bronze.

E. Class 250 Wafer, Single-Plate:
1. Comply with API STD 594.
2. Sizes 2-1/2 to 12 inch: CWP Rating; 400 psi.
3. Sizes 14 to 24 inch: CWP Rating; 300 psi.
4. Body Design: Wafer, spring-loaded plate.
5. Body Material: ASTM A126, gray iron.
6. Resilient Seat: EPDM.

2.16 BRONZE, GATE VALVES

A. Rising Stem (RS):
1. Comply with MSS SP-80, Type I.
2. Class 125: CWP Rating; 200 psi.
3. Class 150: CWP Rating; 300 psi.
4. Body Material: Bronze with integral seat and union-ring bonnet.
5. Ends: Threaded.
6. Stem: Bronze.
7. Disc: Solid wedge; bronze.
8. Packing: Asbestos free.
9. Handwheel: Malleable iron, bronze, or aluminum.

2.17 IRON, GATE VALVES

A. OS & Y:
1. Comply with MSS SP-70, Type I.
2. Class 125:
   a. Sizes 2-1/2 to 12 inch, CWP Rating; 200 psi.
   b. Sizes 14 to 24 inch, CWP Rating; 500 psi.
3. Class 250:
   a. Sizes 2-1/2 to 12 inch, CWP Rating; 500 psi.
   b. Sizes 14 to 24 inch, CWP Rating; 300 psi.
4. Body Material: Gray iron with bolted bonnet.
5. Ends: Flanged.
6. Trim: Bronze.
7. Disc: Solid wedge.
8. Packing and Gasket: Asbestos free.

2.18 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

3.01 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.

3.02 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

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SECTION 23 0548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

A. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; Most Recent Edition Cited by Referring Code or Reference Standard.

1.04 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
    1. Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
    2. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.
    3. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable; indicate equipment mounting provisions.
    4. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.

1.05 QUALITY ASSURANCE

A. Comply with applicable building code.
B. Perform design and installation in accordance with applicable codes.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION REQUIREMENTS

A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing HVAC equipment and/or HVAC connections to vibration-isolated equipment.
B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:
C. General Requirements:
    1. Select vibration isolators to provide required static deflection.
    2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.

2.02 MANUFACTURERS

A. Mason Industries: www.mason-ind.com.

2.03 PERFORMANCE REQUIREMENTS

A. General:
    1. All vibration isolators, base frames and inertia bases to conform to all uniform deflection and stability requirements under all operating loads.
    2. Steel springs to function without undue stress or overloading.
    3. Steel springs to operate in the linear portion of the load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
    4. Lateral to vertical stiffness ratio to not exceed 0.08 with spring deflection at minimum 75 percent of specified deflection.
    5. All equipment mounted on vibration isolated bases to have minimum operating clearance of 2 inches between the base and floor or support beneath unless noted otherwise.

2.04 VIBRATION-ISOLATED EQUIPMENT SUPPORT BASES

A. Structural Bases:
    1. Construction: Engineered, structural steel frames with welded brackets for side mounting of the isolators.
    2. Frames: Square, rectangular or T-shaped.

3. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers. Conform with

B. Concrete Inertia Bases:
   1. Type BMK or K.
   2. Construction: Engineered, steel forms, with integrated isolator brackets and anchor bolts, welded or tied reinforcing bars running both ways in a single layer.
   3. Size: 6 inches minimum depth and sized to accommodate elbow supports.
   4. Mass: Minimum of 1.5 times weight of isolated equipment.
   5. Connecting Point: Reinforced to connect isolators and snubbers to base including template and fastening devices for equipment.
   6. Concrete: Filled on site with minimum 3000 psi concrete. See Section 03 3000 for additional requirements.
   7. Applications: Base mounted pumps not located slab on grade.
      a. Bases shall be large enough to provide support for the entire width and length of the pump including the suction diffuser.

C. House Keeping Pads:
   1. Sub-bases shall be provided for all machinery such as fans, boilers, pumps, air compressors and refrigeration machines. Each electric motor shall be mounted on the same sub-base as the driven machine.
   2. 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.
   3. Bases shall be 6 inches larger than equipment footprint.

2.05 VIBRATION ISOLATORS

A. General Requirements:
   1. Resilient Materials for Vibration Isolators: Oil, ozone, and oxidant resistant.

B. Non-Seismic Type:
   1. All Elastomeric-Fiber Glass Pads:
      a. Configuration: Flat or molded.
      b. Thickness: 0.25 inch minimum.
      c. Assembly: Single or multiple layers using bonded, galvanized sheet metal separation plate between each layer with load plate providing evenly distributed load over pad surface.
   2. Elastomeric Mounts:
      a. Material: Oil, ozone, and oxidant resistant compounds.
      b. Assembly: Encapsulated load transfer plate bolted to equipment and base plate with anchor hole bolted to supporting structure.
   3. Steel Springs:
      a. Assembly: Freestanding, laterally stable without housing.
      b. Leveling Device: Rigidly connected to equipment or frame.
   4. Elastomeric Hangers:
      a. Housing: Steel construction containing elastomeric isolation element to prevent rod contact with housing and short-circuiting of isolating function.
      b. Incorporate steel load distribution plate sandwiching elastomeric element to housing.
   5. Combination Elastomeric-Spring Hanger:
      a. Housing: Steel construction containing stable steel spring with elastomeric element in series isolating upper connection of hanger box to building structure.
      b. Bottom Opening: Sized to allow plus/minus 15 degrees rod misalignment.

PART 3 EXECUTION

3.01 INSTALLATION

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

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

C. Secure fasteners according to manufacturer's recommended torque settings.

D. Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.

E. Vibration Isolation Systems:
   1. Vibration-Isolated Equipment Support Bases:
      a. Provide specified minimum clearance beneath base.
   2. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
   3. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
   4. Adjust isolators to be free of isolation short circuits during normal operation.
   5. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.

3.02 INSTALLATION - GENERAL

A. Install in accordance with manufacturer's instructions.

B. Bases:
   1. Set steel bases for one inch clearance between housekeeping pad and base.
   2. Set concrete inertia bases for 2 inches clearance between housekeeping pad and base.
   3. Adjust equipment level.

C. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

END OF SECTION

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SECTION 23 0553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.
B. Tags.
C. Adhesive-backed duct markers.
D. Pipe/Duct markers.
E. Ceiling markers.

1.02 REFERENCE STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.
B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.

1.03 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

2.01 IDENTIFICATION APPLICATIONS

A. Air Handling Units: Nameplates.
B. Air Terminal Units: Tags.
C. Automatic Controls: Tags. Key to control schematic.
D. Control Panels: Nameplates.
E. Dampers: Ceiling tacks, where located above lay-in ceiling.
F. Ductwork: Duct Markers.
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: Nameplates.
N. Valves: Tagsand/or ceiling tacks where located above a finished ceiling..

2.02 NAMEPLATES

A. Manufacturers:
    1. Brimar Industries, Inc: www.pipemarker.com/#sle.
    2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
    3. Seton Identification Products, a Tricor Direct Company: www.seton.com.
    4. Substitutions: See Section 01 6000 - Product Requirements.
B. Letter Color: White.
C. Letter Height: 1/2 inch.
D. Background Color: Black.
E. Plastic: Comply with ASTM D709.

2.03 TAGS

A. Manufacturers:
    1. Brady Corporation: www.bradycorp.com.
    2. Brimar Industries, Inc: www.pipemarker.com/#sle.
    3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com.
    4. 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.

2.04 ADHESIVE-BACKED DUCT MARKERS

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/#sle.
   4. Substitutions: See Section 01 6000 - Product Requirements.
B. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
C. Style: Individual Label.
D. Color:
   1. Green with white letters: For cold-air supply ducts.
   2. Yellow with black letters: For hot-air supply ducts.
   3. Blue with white letters: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

2.05 PIPE MARKERS

A. Manufacturers:
   1. Brady Corporation: www.bradycorp.com.
   2. Brimar Industries, Inc: www.pipemarker.com/#sle.
   3. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
   4. Seton Identification Products, a Tricor Company: www.seton.com.
   5. Substitutions: See Section 01 6000 - Product Requirements.
B. Color: Comply with ASME A13.1.
C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. (Pipes over 1 inch in diameter)
D. Underground Plastic Pipe Markers: Bright-colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil, 0.004 inch thick, manufactured for direct burial service.
E. 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.

2.06 CEILING MARKERS

A. Manufacturers:
   1. Craftmark: www.craftmarkid.com.
   2. Moore
   3. Seton
   4. Substitutions: See Section 01 6000 - Product Requirements.
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

3.01 PREPARATION

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

3.02 INSTALLATION

A. Piping shall be identified as to contents using the following list:

Low Pressure Steam	L.P. STEAM
Glycol Hot Water Heating Supply	GHWS
Glycol Hot Water Heating Return	GHWR
42F Glycol Chilled Water Supply	CHWS

57F Glycol Chilled Water Return	CHWR
Condensate	COND.
57F Chilled Water Supply	CHWS 57
62F Chilled Water Return	CHWR 62
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.
K. Identify all exposed ductwork.
L. All piping and ductwork to be labeled with markers (not stenciled).

END OF SECTION

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SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Testing, adjustment, and balancing of air systems.
B. Testing, adjustment, and balancing of hydronic, Domestic Water, and steam systems.
C. Measurement of final operating condition of HVAC systems.
D. Commissioning activities.

1.02 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; 2008, with Errata (2019).
C. NEBB (TAB) - Procedural Standard for Testing Adjusting and Balancing of Environmental Systems; 2019.
D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2023.

1.03 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.

1.04 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.

1.05 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.

1.06 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.

1.07 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

3.01 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.

3.02 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.

3.03 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.

3.04 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.

3.05 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.

3.06 FUME HOOD TESTING (ON SITE)

A. General: Test fume hoods as installed to assess airflow velocity, airflow visualization, and level of containment. Perform tests with static mode (set sash position) conditions. Conduct testing as outlined below for 100% of the hoods provided in the Project.

B. Preparation: Visit the project site to confirm that construction activities related to the fume hood system(s) and equipment are complete. Review design documents and Contractor's submittals. Verify that mechanical ventilation systems serving the space are functioning and operating in the normal mode. Notify Owner in writing, if conditions exist which preclude proper fume hood testing. Starting of testing constitutes acceptance of site conditions.

3.07 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.

3.08 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.

3.09 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%.

3.10 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.

3.11 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 3100

B. Testing supply, return and exhaust 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 3100. 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.

3.12 BUILDING STATIC PRESSURE

A. The balancing contractor shall perform building static pressure control balancing during all ranges of air handling unit sequences including unoccupied, occupied, minimum to maximum airflow and economizer operation for all air handling units. Systems shall be balanced to maintain the building between +0.02 in.w.g to +0.05 in.w.g.

B. Systems designed with active building pressure controls sensing differential pressure between an interior space and exterior space, or between two interior spaces, shall be balanced in coordination with the automatic temperature control contractor to increase or decrease the volume of air handled by the return / exhaust air fan as building pressure increases.

C. Systems without active building pressure controls shall utilize closed loop control (fan tracking). The closed loop balancing procedure shall sense changes in the volume of air the supply air fan delivers and use a controller

having a second input proportional to the return air fan flow to reset the return air fan speed. Controlling of the return air flow in response to supply air flow shall take careful measurements of the building pressure throughout the full range of airflow during the balancing procedure to provide the correct inputs for the automatic temperature control contractor.

3.13 COMMISSIONING

A. See Sections 01 9113 - General Commissioning Requirements and 23 0800 for additional requirements.
B. Perform prerequisites prior to starting commissioning activities.
C. Fill out Prefunctional Checklists for:
   1. Air side systems.
   2. Water side systems.
D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
E. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for ___ percent of the air handlers plus a random sample equivalent to ____ percent of the final TAB report data as directed by Commissioning Authority.
   1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
   2. Use the same test instruments as used in the original TAB work.
   3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
   4. For purposes of re-check, failure is defined as follows:
      a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
      b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
      c. Temperatures: Deviation of more than one degree F.
      d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
      e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.
   5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.
F. In the presence of the Commissioning Authority, verify that:
   1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
   2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
   3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

3.14 SCOPE

A. Test, adjust, and balance the following:
   1. Fire Pumps.
   2. Plumbing Pumps.
   3. Domestic Hot Water Recirculation System
   4. Steam Condensate Pumps.
   5. HVAC Pumps.
   6. Air Cooled Water Chillers.
   7. Heat Recovery Chiller.

8. Packaged Roof Top Heating/Cooling Units.
9. Air Coils.
10. Induction Units.
11. Air Handling Units.
12. Fans.
13. Air Filters.
14. Air Terminal Units.
15. Air Inlets and Outlets.
16. Fume Hoods.
17. Room Pressurization.
18. Building Pressurization.

3.15 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. Chillers:
1. Identification/number.
2. Manufacturer.
3. Capacity.
4. Model number.
5. Serial number.
6. Evaporator entering water temperature, design and actual.
7. Evaporator leaving water temperature, design and actual.
8. Evaporator pressure drop, design and actual.
9. Evaporator water flow rate, design and actual.
10. Condenser entering water temperature, design and actual.

11. Condenser pressure drop, design and actual.
12. Condenser water flow rate, design and actual.

E. Heat Exchangers:
1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Model number.
6. Serial number.
7. Primary water entering temperature, design and actual.
8. Primary water leaving temperature, design and actual.
9. Primary water flow, design and actual.
10. Primary water pressure drop, design and actual.
11. Secondary water leaving temperature, design and actual.
12. Secondary water flow, design and actual.
13. Secondary water pressure drop, design and actual.

F. 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.

G. 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.

H. Induction Units:
1. Manufacturer.
2. Identification/number.
3. Location.
4. Model number.
5. Size.
6. Design air flow.
7. Design nozzle pressure drop.
8. Final nozzle pressure drop.
9. Final air flow.

I. 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.

J. 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.

K. 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.

L. 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.

M. Air Monitoring Stations:
1. Identification/location.
2. System.
3. Size.
4. Area.
5. Design velocity.
6. Design air flow.
7. Test velocity.
8. Test air flow.

N. Flow Measuring Stations:
1. Identification/number.
2. Location.
3. Size.
4. Manufacturer.
5. Model number.
6. Serial number.
7. Design Flow rate.
8. Design pressure drop.
9. Actual/final pressure drop.
10. Actual/final flow rate.
11. Station calibrated setting.

O. 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.

P. 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.

Q. Fume Hoods

END OF SECTION

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SECTION 23 0713 - DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Duct insulation.

1.02 REFERENCE STANDARDS

A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2017.

B. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).

C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.

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

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

1.03 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.

1.04 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.

1.05 DELIVERY, STORAGE, AND HANDLING

1.06 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

2.01 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.

2.02 GLASS FIBER, FLEXIBLE

A. Manufacturer:

1. CertainTeed Corporation; _____: www.certainteed.com/#sle.
2. Knauf Insulation: www.knaufinsulation.com.
3. Johns Manville: www.jm.com.
4. Owens Corning Corporation: www.ocbuildingspec.com.
5. Substitutions: See Section 01 6000 - Product Requirements.

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.

2.03 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.
4. Substitutions: See Section 01 6000 - Product Requirements.

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.

2.04 FIRE RATED DUCT WRAP INSULATION

A. Manufacturers:
1. FireMaster Fast Wrap+
2. 3M Fire Barrier Duct Wrap 615+
3. Substitutions: See Section 01 6000 - Product Requirements.

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.

PART 3 EXECUTION

3.01 EXAMINATION

A. Test ductwork for design pressure prior to applying insulation materials.

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

3.02 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, 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.

F. Dedicated outdoor air ductwork inside the building envelope, after the make-up air devices with heating & cooling coils, burners, etc., does not require insulation when the air is tempered to room neutral air conditions (approx. 720F) and used for ventilation purposes only. All non-tempered, outdoor air shall be insulated in the thickness & density described above.

G. 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.

H. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Finish with rigid fiberglass.

I. 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.

J. 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.

K. 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. Ventilation Air Ducts (1 and 2 hr. Enclosure): Install fire resistive duct wrap insulation in direct contact with ductwork to Manufacturer's instructions and referenced standards, including Listed penetration firestop

system.

a. Apply fire resistive duct wrap insulation continuously to ductwork provide one layer of Fire Barrier Duct Wrap with 3 inch overlaps for 1 and 2 hour applications. Observe requirements for additional duct wrap material required at firestop, when required. Tape seams using minimum 3 inch (76mm) wide aluminum foil adhesive tape.

3. 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.
4. 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.
5. Duct Access Doors: Install duct wrap to Manufacturer's instructions and procedures.
6. 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.
   c. Ventilation ducts: Fire resistive insulation may pass continuously through fire rated wall or floor penetrations or may tightly butt to both sides of fire rated separations. Minimum 1 inch, maximum 3 inch clearance permitted around unwrapped duct in opening or from edge of opening to outer layer of duct wrap. Consult individual Listed firestop systems for specific requirements.
      1) Terminate wrap at fire separation. Fill space around unwrapped duct where it passes through a fire rated wall or floor with pieces of 3M duct wrap insulation or mineral wool insulation firmly packed into opening. Compress to the percentage stated in the firestop listing to full depth of floor or wall. Recess packing on both sides of walls or top side of floor to depth stated in firestop listing. Seal over packing material using 3M firestop sealant to depth stated in firestop listing, flush with top side of floor and both sides of wall surfaces. Tightly butt fire resistive duct wrap insulation to each side of wall or floor assembly and seal interface with a continuous bead of 3M firestop sealant.

3.03 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
Mixed Air Duct	Glass fiber flexible	2 inch	1-1/2 lb/ft^3
Outdoor Air Duct	Glass fiber rigid	3 inch	3 lb/ft^3
Relief Duct	Glass fiber flexible	2 inch	1-1/2 lb/ft^3

B. **Fan Coil 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		
Mixed Air Duct	Glass fiber flexible	2 inch	1-1/2 lb/ft^3
Outdoor Air Duct	Glass fiber rigid	3 inch	3 lb/ft^3
Relief Duct	Glass fiber flexible	2 inch	1-1/2 lb/ft^3

C. **Energy Recovery Units**

Ductwork System	Insulation Type	Insulation Thickness	Density
Supply Duct	Glass fiber flexible	2.2 inch (R value - 6)	3/4 lb/ft^3
Exhaust Air Duct from unit outlet to building outlet	Glass fiber flexible	2 inch	1-1/2 lb/ft^3
Outdoor Air Duct	Glass fiber rigid	3 inch	3 lb/ft^3

D. **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

E. **Relief Air Hoods and Louvers**

Ductwork System	Insulation Type	Insulation Thickness	Density
Relief Duct 10 feet back from isolation damper	Glass fiber flexible	2 inch	1-1/2 lb/ft^3

F. **Ventilation Duct Fire Wrap**

Ductwork System	Insulation Type	Insulation Thickness	Density
Stais, Corridors as indicated	Ceramic Fire Wrap	3 inch total (2 layers of 1-1/2 inch w/ staggered seams)	8 lb/ft^3

G. **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	None	None
Mixed Air Duct	Glass fiber rigid	2 inch	3 lb/ft^3
Outdoor Air Duct	Glass fiber rigid	3 inch	3 lb/ft^3
Combustion Air Duct	Glass fiber rigid	3 inch	3 lb/ft^3
Exhaust Air Duct	Glass fiber rigid	2 inch	3 lb/ft^3
Relief Duct	Glass fiber rigid	2 inch	3 lb/ft^3

END OF SECTION

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SECTION 23 0716 - HVAC EQUIPMENT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Equipment insulation.
B. Jacketing and accessories.

1.02 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.
B. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2017.
C. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2023.
D. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2022a.
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; 2021a.
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.

1.03 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.

1.04 QUALITY ASSURANCE

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

1.05 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.

1.06 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

2.01 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.

2.02 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.
    5. Substitutions: See Section 01 6000 - Product Requirements.
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.

2.03 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.
   4. Substitutions: See Section 01 6000 - Product Requirements
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.

2.04 JACKETING AND ACCESSORIES

A. PVC Plastic:
   1. Manufacturers:
      a. Johns Manville Corporation: www.jm.com.
      b. Substitutions: See Section 01 6000 - Product Requirements.
   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

3.01 EXAMINATION

A. Verify that equipment has been tested before applying insulation materials.
B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 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 containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
I. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.
J. Cold water or pressure tanks:
   1. Insulate with 3/4" 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 fit the contour of the tank with no void left between tank body and insulation. Installation of insulation shall be a neat workmanlike manner.
K. Chilled Water systems:
   1. Expansion tank(s), side stream filter cartridge container, air separator fitting and pump volute(s) shall be insulated with 3/4" 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 equipment. Insulation shall be installed to minimize any void between the insulation and equipment. Installation of insulation shall be a neat workmanlike manner.

L. Heating Air Seperator and Heat Exchanger Insulation:
   1. 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.

M. Side Stream Filters serving Heating Water and Chilled 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.

N. Water Heaters or hot water storage tanks:
   1. For tanks of 140 degrees or below:
      a. Hot water storage tank system shall be insulated with 2" thick pre-molded fiberglass pipe insulation, 4 lb. density. All seams shall be taped smooth. Ends shall be finished with mastic, troweled smooth.

O. 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 and Chilled 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.

P. Finish insulation at supports, protrusions, and interruptions.

Q. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.

R. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

S. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

END OF SECTION

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SECTION 23 0719 - HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping insulation.
B. Flexible removable and reusable blanket insulation.
C. Jacketing and accessories.

1.02 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.
B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement; 2007 (Reapproved 2019).
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; 2021a.
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.

1.03 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.

1.04 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 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.

2.02 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.
    5. Substitutions: See Section 01 6000 - Product Requirements.
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.

2.03 JACKETING AND ACCESSORIES

A. PVC Plastic.
    1. Manufacturers:

a. Johns Manville Zeston 2000 Series White PVC or equal.
b. Substitutions: See Section 01 6000 - Product Requirements.

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.

2.04 HIGH TEMPERATURE FITTING INSULATION:

A. All steam valves including control valves, expansion joints and the access end of strainers shall be covered with a custom fabricated insulation jacket secured around the fitting. Jacket shall be similar to "Energy-Wrap" as fabricated by Thermal Energy Products, Inc. Insulation Systems will be custom designed and engineered for each individual item which is not a standard product based on type of application, operating temperature, and environment. A close contour fit is essential for proper thermal performance and neat appearance.

B. Insulation jacket shall be constructed of PTFE Teflon Impregnated Fiberglass Cloth with a temperature rating to 550°F, 0.016 Inch Thickness and Dark Grey in color. Insulation shall be one (1") Inch Thick, Thinsulate ä Insulation Type B400. Insulation shall meet Flammability Test Class 1-16 CFR Part 1610 and have an R-Value of 1.58.

C. Insulation jacket shall be secured to the fitting with Woven Nylon Hook and Loop Velcro, Grey Color, Maximum Temperature Resistance 250°, V-0 UL94 Burn Test, 1.20 Lbs Peel Strength. Heavy Duty Velcro shall be located at edges where covers will butt together. Insulation Seams which do not tightly butt one another are Not Acceptable.

D. All reusable insulation blanket assemblies shall be labeled with a 1" x 2" white laser label. The tagging systems will facilitate installation and reinstallation of all blankets and enable the manufacturer to provide replacements upon request by number assigned as imprinted on the label.

E. All blanket seams shall be double sewn lock stitched interior seams (except for final closure). Stitching to be ten (10) to fourteen (14) stitches per inch and one quarter (1/4") inch spacing between seams. Hog ringed blankets are not acceptable.

2.05 LOW TEMPERATURE 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.

2.06 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

3.01 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.

3.02 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 conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

I. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

J. 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.

K. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.

3. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

L. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 8400.

M. PVC jackets on insulation shall be installed on all exposed piping less than 8 feet above finished floor in all mechnaical rooms, storage rooms, janitor closets, and/or as noted on drawings.

N. 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.

O. Buried Piping: Provide factory-fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil, 0.001 inch thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

3.03 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
201F to 250F	3 inch and less	2-1/2 inch
	4 inch and greater	3 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. Steam Heating Systems

1. Steam and Condensate: Glass Fiber, Rigid.

Service	**Pipe Size**	**Insulation Thickness**
LP Steam 201F to 250F	1-1/2 inch and less	2-1/2 inch
	2 inch and greater	3 inch
Condensate	All	1-1/2 inch
Flash Tank Vents	All	3 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".

C. Cooling Systems

Service	**Pipe Size**	**Insulation Thickness**
Chilled Water	All	1-1/2 inch Rigid Fiberglass with vapor barrier
Cooling Coil Condensate	All	3/4 inch Flexible Elastomeric Foam

END OF SECTION

SECTION 23 0784 - MECHANICAL FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Firestopping systems.

B. Firestopping of all mechanical through and membrane penetrations in fire-resistance rated and smoke-resistant assemblies , whether indicated on drawings or not .

1.02 REFERENCE STANDARDS

A. ASTM E 814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops; 2009.

B. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.

C. FM 4991 - Approval of Firestop Contractors; Factory Mutual Research Corporation; 2001.

D. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.

E. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.

F. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.03 SUBMITTALS

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

B. Shop Drawings:

1. Schedule of Firestopping: List each type of penetration.
2. Product Data: Provide data on product characteristics.

C. Closeout Documents:

1. Certificate from authority having jurisdiction indicating approval of materials used.

1.04 QUALITY ASSURANCE

A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.

1. Listing in the current-year classification or certification books of UL, FM, or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.
2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.

B. Installer Qualifications: Company specializing in performing the work of this section and:

1. Approved by Factory Mutual Research under FM Standard 4991, Approval of Firestop Contractors , or meeting any two of the following requirements:.
2. With minimum 3 years documented experience installing work of this type.
3. Able to show at least 5 satisfactorily completed projects of comparable size and type.
4. Licensed by authority having jurisdiction.

1.05 MOCK-UP

A. Install one firestopping assembly representative of each fire rating design required on project.

B. Obtain approval of authority having jurisdiction before proceeding.

C. If accepted, mock-up will represent minimum standard for the Work.

D. If accepted, mock-up may remain as part of the Work. Remove and replace mock-ups not accepted.

1.06 SCOPE / APPLICATION

A. Provide installed firestop protects that limit the spread of fire, heat, smoke, and gasses through otherwise unprotected openings in rated assemblies, including walls, partitions, floors, roof/ceilings, and similar locations. restoring the integrity of the fire rated construction to its original fire rating.

B. Provide firestop systems listed for the specific combination of fire rated construction, type of penetrating item, annular space requirements, and fire rating, and the following criteria:

1. F-Rating: Equal to or greater than the fire-resistance rating of the assembly in which the firestopping will be installed.
2. T-Rating: In habitable areas where penetrating items are exposed to potential contact with materials on fire side(s) of rated assembly, T-rating must equal its F-rating.
3. L-Rating: L-rating of 1 cfm per linear foot (5.5 cu m/h/m) maximum at ambient temperatures.
4. Wall Penetrations: Systems must be symmetrical, with the same rating from both sides of the wall.

1.07 FIELD CONDITIONS

A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. 3M Fire Protection Products: www.3m.com/firestop.

B. Hilti, Inc: www.us.hilti.com.

C. Substitutions: See Section 01 6000 - Product Requirements.

2.02 THROUGH PENETRATION FIRESTOP SYSTEMS

A. Firestopping: Any material meeting requirements.

1. Fire Ratings: Use any system listed by UL or tested in accordance with ASTM E 814 that has F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and that meets all other specified requirements.

2.03 MATERIALS

A. Firestopping Sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.

B. Cast-in-Place Devices: Firestopping device for use prior to a concrete pour. Adjustable height with pull tabs, straight edge design for close placement to walls and adjacent devices.

1. Fire Resistance: For use in 1, 2, or 3 hour fire rated systems.

C. One piece metal collar assembly encasing intumescent material for firestopping of pipes and cables through rated walls and floors.

1. Fire Resistance: For use in 1 or 2 hour fire rated systems.

D. Plastic Pipe Device: Intumescent device for firestopping of plastic pipe and cables through rated walls and floors.

1. Configuration: One-piece metal collar, with locking latch and bendable tabs to secure; equipped also for conventional anchoring.
2. Fire Resistance: For use in 1, 2 or 3 hour fire rated systems.

E. Elastomeric Silicone Firestopping: Single component silicone elastomeric compound and compatible silicone sealant;

1. Fire Resistance: For use in 1, 2 or 3 hour fire rated systems.

F. Foam Firestoppping: Single component silicone foam compound;

G. Fibered Compound Firestopping: Formulated compound mixed with incombustible non-asbestos fibers;

H. Fiber Firestopping: Mineral fiber insulation used in conjunction with elastomeric surface sealer forming airtight bond to opening;

I. Firestop Devices - Wrap Type: Mechanical device with incombustible filler and sheet stainless steel jacket, intended to be installed after penetrating item has been installed;

J. Firestop Devices - Cast-In Type: Sleeve and sealing material, intended to be cast in concrete floor forms or in concrete on metal deck, not requiring any additional materials to achieve penetration seal.

1. Durability and Longevity: Permanent.

K. Intumescent Putty: Compound that expands on exposure to surface heat gain.

1. Fire Resistance: For use in 1, 2 or 3 hour fire rated systems.

L. Reusable Firestopping: Removable intumescent compressible shapes, pillows, or blocks specifically tested in removable configuration;:

M. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION

A. Do not begin installation until substrates have been properly prepared.

B. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.

C. Remove incompatible materials that could adversely affect bond.

D. Install backing materials to arrest liquid material leakage.

E. Verify that items penetrating fire rated assemblies are securely attached, including sleeves, supports, hangers, and clips.
F. Verify that openings and adjacent areas are not obstructed by construction that would interfere with installation of firestopping, including ducts, piping, equipment, and other suspended construction.
G. Install masking and temporary coverings as required to prevent contamination or defacement of adjacent surfaces due to firestopping installation.

3.03 INSTALLATION

A. Non-rated assemblies shall be draft stopped.
B. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
C. Install so that openings are completely filled and material is securely adhered.
D. Where firestopping surface will be exposed to view, finish to a smooth, uniform surface flush with adjacent surfaces.
E. After installation is complete, remove combustible forming materials and accessories that are not part of the listed system.
F. Clean firestop materials off surfaces adjacent to openings as work progresses, using methods and cleaning materials approved in writing by firestop system manufacturer and which will not damage the surfaces being cleaned.
G. Do not cover firestopping with other construction until approval of authority having jurisdiction has been received.
H. Do not cover installed firestopping until inspected by authority having jurisdiction.
I. Install labelling required by code.
J. Install identification Labels for Through Penetration and Construction Joint Systems: Pressure sensitive self-adhesive vinyl labels, preprinted with the following information:
    1. The words "Warning - Through Penetration Firestop System - Do not Disturb. Notify Building Management of Any Damage."
    2. Listing agency's system number or designation.
    3. System manufacturer's name, address, and phone number.
    4. Installer's name, address, and phone number.
    5. General contractor's name, address, and phone number (if applicable).
    6. Date of installation.

3.04 CLEANING

A. Clean firestop materials off surfaces adjacent to openings as work progresses, using methods and cleaning materials approved in writing by firestop system manufacturer and which will not damage the surfaces being cleaned
B. Clean adjacent surfaces of firestopping materials.

3.05 PROTECTION

A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

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SECTION 23 0913 - INSTRUMENTS AND CONTROL ELEMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Dampers.
B. Damper Operators:
C. Thermostats.
D. Control valves.
E. Electronic valve actuators
F. Automatic dampers.
G. Damper operators.
H. Temperature sensors
I. Humidity sensors
J. Outside air sensors
K. Duct mounted sensors
L. Pressure sensors
M. Differential pressure sensors
N. Electronic signal isolation transducer
O. Airflow measuring station
P. Carbon dioxide sensors
Q. Variable Frequency Drive
R. Time clocks.

1.02 REFERENCE STANDARDS

1.03 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.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this sectionwith minimum ten (10) years experience approved by manufacturer.

1.05 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.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 EQUIPMENT - GENERAL

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.02 CONTROL VALVES

A. Control valves shall be 2-way or 3-way mixing as shown 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.

2.03 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 to last position.

B. Actuators serving AHU heating valves shall fail open. Actuators serving AHU cooling valves shall fail closed. Actuators serving steam valves shall fail to last position. Valve actuators shall be UL-recognized or CSA-certified.

C. Provide spring return normally open actuators on air handling unit heating valves and radiation valves.

D. Provide spring return normally closed actuators on chilled water valves.

2.04 DAMPERS

A. Dampers are specified under 23 3300. This contractor shall verify all sizes and provide appropriate damper operators for all dampers.

2.05 DAMPER OPERATORS

A. 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.

B. 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.

C. 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.

D. Provide normally closed (spring return) actuators at Outside Air, Relief Air, and Exhaust Air damper locations unless otherwise indicated.

2.06 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. Chilled water, 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 throughout the building 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.

2.07 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.

2.08 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.

2.09 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 ELECTRONIC SIGNAL ISOLATION TRANSDUCERS

A. A signal isolation transducer shall be provided whenever an analog output signal from the BMS is to be connected to an external control system as an input (such as a boiler or chiller control panel), or is to receive as

an input signal from a remote system. The signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems.

2.13 AIRFLOW MEASURING STATION

A. Provide and install airflow measuring station(s) capable of continuously monitoring the fan or duct air volumes. Airflow measuring stations will be provided where indicated in sequences/on plans. Airflow measuring stations shall be either duct mounted or fan inlet type as indicated on the plans.

B. The airflow/temperature measurement station (AFMS) shall be capable of monitoring airflow and temperature rates at each measurement location. Sensors shall use thermal dispersion technology with two "bead in glass", hermetically sealed thermistor probes at each measurement point. The system shall be factory tested prior to shipment and not require calibration or adjustment over the life of the equipment when installed in accordance to manufacturer's guidelines.

C. Each sensor probe shall be provided with a UL plenum-rated connecting cable. All sensor calibration data shall be stored in the sensor probe. No additional devices or transducers shall be required to interface with the host controls.

D. Sensors shall be factory-calibrated to NIST-traceable standards for both airflow and temperature. Each sensing point shall independently measure airflow and temperature prior to averaging. Installed accuracy shall be percent of reading and demonstrated at both maximum and minimum airflow rates for each measurement location.

E. The airflow measuring station(s) shall be fabricated of a minimum of 14 ga. galvanized steel, welded casing in 8" depth with 90º connecting flanges in a configuration and size equal to that of the duct it is mounted into. Each station shall be complete with an open parallel cell air straightener-equalizer honeycomb mechanically fastened to the casing, and external signal connection fittings. An identification label shall be placed on each station casing listing model number, size, area, and specified airflow capacity.

F. The transmitter shall be microprocessor-based. The transmitter shall operate on 24 VAC and be internally fused and protected. Analog output signals shall be field selectable (0-10 VDC or 4-20 mA). All inputs and outputs shall be fused, protected, and internally isolated from the 24 VAC power supply. The transmitter shall have a digital adjustment for output signal offset/gain and an adjustable digital filter for airflow output. The transmitter shall accept a user-defined area for CFM display. The transmitter shall be capable of continuously performing sensor and transmitter diagnostics and perform a full system check on power-up. A sensor detection system shall ignore any malfunctioning sensors and send an alarm to BAS.

G. The enclosure shall be aluminum alloy for indoor use and capable of operating over a temperature range of +30° F to +120° F. The electronics shall be installed inside and protected from the weather. (NEMA4 for outdoor use).

H. Sensor probes shall be constructed of anodized aluminum alloy tube with stainless steel mounting brackets. Probes shall be constructed as insertion, internal, or standoff mounting, depending on the installation requirements.

I. The sensor accuracy for airflow shall be at least ±2% of Reading over the sensor probe operating ranges. The installed total accuracy for airflow shall be better than ±3% of Reading over the sensor probe operating ranges when installed in accordance with manufacturers' guidelines. The sensor accuracy for temperature shall be better than ±0.15° F over the entire operating range.

J. Installation of airflow measuring station is to be performed by the manufacturer's representative. Installation is to include identifying proper installation locations, measurement of the installation location, installation of the product, and commissioning to functional specified accuracy.

K. Acceptable manufacturers shall include Ebtron, Air Monitor or approved equal.

2.14 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

2.15 CARBON MONOXIDE/NITROGEN DIOXIDE SENSOR:

A. Manufacturers:
   1. American Gas Safety (AGS)
   2. Brasch Environmental Technologies
   3. Honeywell
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Carbon monoxide/Nitrogen dioxide control system shall consist of a control panel, which contains a power supply, clocks, visual display of gas concentration, audible and visual alarms, delays, relays, one carbon monoxide sensor, and one nitrogen dioxide sensor, and shall be UL 2075 listed.

C. Switches shall be provided for field adjustment of the gas detection level for the low-alert, and of the on/off time delay for the low-alert and high-alert. Selectable CO detection levels shall range from 20 to 55 ppm and the NO2 detection levels shall range from 0.3 to 4.0 ppm. Selectable time delays shall range from 0 to 7 minutes, in 1 minute increments.

D. An external push button on the front of the enclosure shall be provided to silence the internal alarm. The alarm circuit shall become active again, once the detector is no longer at alarm levels.

E. The control panel shall contain the following items on the panel face: power "on" light, remote sensor power "on" lights, fan "on" light, dual level alarm "on" light, alarm "silence" switch, and all necessary displays and keypads to set warning and alarm levels and a LCD display indicating carbon monoxide level. Alarm panel shall be provided with manual by-pass to permit use of make-up air and exhaust manually.

F. Carbon monoxide (CO) sensor shall be mounted at 5’-0” above finished floor. Controller shall be mounted at the same height. Nitrogen dioxide (NO2) sensor shall be mounted 12” below the roof structure.

G. The equipment manufacturer shall provide the on-site services of a factory technician to train designated personnel in sensor maintenance, calibration and troubleshooting.

H. All electrical work required to interconnect multiple controllers shall be done by this contract. It shall be this contractor’s responsibility to coordinate and provide the appropriate information to the electrician so that the system will be operational.

I. The exhaust fan and make-up air motorized damper shall be interlocked by this contractor to operate in unison on call from the control system.

2.16 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, Mitsubishi, Allen Bradley, Reliance, Danfoss, Square D, Siemens, Honeywell, Trane TR200 or Johnson Controls.

PART 3 EXECUTION

3.01 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.

3.02 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 guards on thermostats in entrances.
G. Provide valves with position indicators and with pilot positioners where sequenced with other controls.
H. Provide separate steam valves for each bank of coils. Provide two valves in parallel where steam load exceeds 1,500 lb/hr with 1/3 to 2/3 load capacities sequenced with smaller valve opening first.
I. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
J. 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.
K. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
L. Identify variable frequency controllers in accordance with Section 26 0553.
M. 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.

3.03 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.

3.04 CLOSEOUT ACTIVITIES

A. Demonstrate operation of VFD controllers in automatic and manual modes.

3.05 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 0923 - DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.01 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.

1.02 REFERENCE STANDARDS

A. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2020, with Errata and Amendments (2021).
B. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests; 2019h.
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.

1.03 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.

1.04 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. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owners name and registered with manufacturer.

1.05 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.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
B. Correct defective Work within a two year period after Substantial Completion.
C. Provide five year manufacturer's warranty for field programmable micro-processor based units.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Johnson Controls, Inc. - Metasys (Fargo Branch Office)

B. Trane

2.02 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 0913.

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.

2.03 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. The CPU shall be a minimum of an Intel Pentium and operate at a minimum of 1,800 MHz. A minimum of 2 gigabytes of RAM, one CD readable/writable drive and a 2TB hard disk with a minimum access time of 12 milliseconds shall be provided. 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 a minimum of a 24" LED monitor (1920 x 1080 resolution).

C. Furnish a concurrent multi-tasking operating system. 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.

2.04 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.

2.05 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.

2.06 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.

2.07 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.

2.08 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

3.01 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.

3.02 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 0993.

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 Section 26 0583. 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

3.03 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.

3.04 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.

3.05 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.

3.06 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.
B. Provide service engineer to instruct Owner's representative in operation of systems plant and equipment for 3 day period.
C. Provide basic operator training for four persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 40 hours dedicated instructor time. Provide training on site.

3.07 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. Include a minimum of ten (10) man hours of dedicated instructor time on-site. Schedule training with Owner with at least 7 days' notice.

3.08 MAINTENANCE

A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
B. Provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion.

C. Provide two complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.
D. 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.

3.09 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

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SECTION 23 2113 - HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hydronic system requirements.
B. Heating water piping, above grade.
C. Chilled water piping, above grade.
D. Equipment drains and overflows.
E. Pipe hangers and supports.
F. Unions, flanges, mechanical couplings, and dielectric connections.

1.02 REFERENCE STANDARDS

A. 24 CFR 51 - Department of Housing and Urban Development Environmental Criteria and Standards; current edition.
B. ASME BPVC-IX - Qualification Standard for Welding, Brazing, and Fuzing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators - Welding Brazing and Fusing Qualifications; 2019.
C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2016.
D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2018.
E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2018.
F. ASME B31.9 - Building Services Piping; 2020.
G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2020.
H. ASTM A183 - Standard Specification for Carbon Steel Track Bolts and Nuts; 2014 (Reapproved 2020).
I. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2019.
J. ASTM A536 - Standard Specification for Ductile Iron Castings; 1984, with Editorial Revision (2019).
K. ASTM B32 - Standard Specification for Solder Metal; 2020.
L. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2020.
M. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
N. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
O. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications; 2018.
P. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2020.
Q. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2021.
R. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80; 2020.
S. 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.
T. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 2024.
U. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2019).
V. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
W. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015, with Errata (2016).
X. AWWA C606 - Grooved and Shouldered Joints; 2015.
Y. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018.
Z. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; 2012.

1.03 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.

1.04 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.

1.05 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.

1.06 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 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. Use non-conducting dielectric connections whenever jointing dissimilar metals.
3. Grooved mechanical joints may be used in accessible locations only.
a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, above ground outdoors, 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.
4. 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.

2.02 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 D1.1/D1.1M welded.
   2. Threaded Joints: ASME B16.3, malleable iron fittings.
   3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

B. Steel Pipe Sizes 12 Inches and Greater: ASTM A53/A53M, 3/8 inch wall, black, using one of the following joint types:
   1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
   2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

C. 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. 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

2.03 CHILLED 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 D1.1/D1.1M welded.
   2. Threaded Joints: ASME B16.3, malleable iron fittings.
   3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

B. Steel Pipe Sizes 12 Inches and Greater: ASTM A53/A53M, 3/8 inch wall, black; using one of the following joint types:
   1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
   2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

C. Copper Tube: ASTM B88 (ASTM B88M), Type K (A) or Type L (B), hard 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. Copper press fittings shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. O-rings for copper 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

D. Pressure Rated Polypropylene Piping:
1. Pipe shall be manufactured from a PP-R or PP-RCT resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. All pipe shall be made in a three layer extrusion process. Domestic hot water shall contain a fiber layer to restrict thermal expansion. All pipe shall comply with the rated pressure requirements of ASTM F 2389. All pipe shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.
2. Fittings shall be manufactured from a PP-R or PP-RCT resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. All fittings shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.
3. Manufacturer shall warrant pipe and fittings for a minimum of 10 years to be free of defects in materials or workmanship. Warranty shall cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system do to defects in materials or workmanship.
4. Where indicated on the drawings that a Plenum-rated Piping System is needed, then the pipe shall be wrapped and/or insulated with standard pipe insulation, field installed. The pipe wrap or insulation shall meet the requirements of CAN/ULC-S102.2-03 or ASTM E84. The system shall have a Flame Spread Classification of less than 25 and Smoke Development rating of less than 50.
5. Install listed pipe materials and joining methods below in the following applications:
a. Aboveground: Polypropylene (PP-R, PP-RCT) piping in SDR 7.3, 9 or 11 based on the required minimum pressure rating and use temperature, in accordance with manufacturer's instructions and ASTM F2389.
6. Install fittings and joints using socket-fusion, elecrofusion, or butt-fusion as applicable for the fitting type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
7. Prior to joining, the pipe and fittings shall be prepared in accordance with the manufacturer's specifications. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications.
8. Install hangers and supports at intervals specified in the applicable Plumbing Code and as recommended by pipe manufacturer. Support vertical piping at each floor and as specified in the applicable Plumbing Code.
9. All PP-R and PP-RCT couplings, fittings and specialties shall be the products of a single manufacturer.
10. Acceptable manufacturers shall be Aquatherm, Niron or an approved equal.

2.04 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tube: 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.

B. PVC Pipe: 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.

2.05 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: Mild 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
   c. Substitutions: See Section 01 60 00 - Product Requirements.

2.06 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

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.
   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.
      b. Substitutions: See Section 01 6000 - Product Requirements.

D. Dielectric Connections:
   1. Waterways:
      a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
      b. Dry insulation barrier able to withstand 600-volt breakdown test.
      c. Construct of galvanized steel with threaded end connections to match connecting piping.
      d. Suitable for the required operating pressures and temperatures.
   2. Flanges:
      a. Dielectric flanges with same pressure ratings as standard flanges.
      b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
      c. Dry insulation barrier able to withstand 600-volt breakdown test.
      d. Construct of galvanized steel with threaded end connections to match connecting piping.
      e. Suitable for the required operating pressures and temperatures.

PART 3 EXECUTION

3.01 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 using jointing system specified.
D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
E. After completion, fill, clean, and treat systems. See Section 23 2500 for additional requirements.

3.02 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. 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.
L. 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.

M. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
N. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors.
O. Use eccentric reducers to maintain top of pipe level.
P. Seal exterior wall penetrations above grade weather tight.
Q. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
R. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
S. Install valves with stems upright or horizontal, not inverted.

3.03 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. Durration: 15 minutes

3.04 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 2114 - HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 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. Automatic flow control valves.
J. Relief valves.

1.02 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023.
B. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi; 2004 (Reaffirmed 2017).

1.03 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 6000 - Product Requirements for additional provisions.
        b. Extra Glycol Solution: One container, 55 gallon size.

1.04 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

2.01 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.
    5. Substitutions: See Section 01 6000 - Product Requirements.
B. Maximum Rated Working Pressure: 125 psi.
C. 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 pressure indicated on schedule, and steel support stand.
D. Accessories: Provide air-charging fitting, epoxy coating finish, pressure gauge, and tank drain ball valve.

2.02 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: 250 degrees F.

2.03 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.
   d. Substitutions: See Section 01 6000 - Product Requirements.
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.

2.04 STRAINERS

A. Manufacturers:

1. Gustin-Bacon
2. Titan
3. Anvil
4. Keckley
5. MetraFlex.
6. Substitutions: See Section 01 6000 - Product Requirements.

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.

2.05 SUCTION DIFFUSERS

A. Manufacturers:

1. Victaulic Company of America: www.victaulic.com.
2. Taco, Inc.
3. Armstrong
4. Gustin-Bacon
5. Grundfos
6. Substitutions: See Section 01 6000 - Product Requirements.

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.

2.06 FLEXIBLE CONNECTORS

A. Manufacturers:

1. The Metraflex Company

2. Flexonics
3. Minnesota Flexible
4. Thermo-tech
5. Twin City Hose
6. EFP
7. Substitutions: See Section 01 6000 - Product Requirements.

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 240 degrees F working temperature. Connectors shall allow pipe movement of at least 1/2" to either side of centerline
4. For pumps with spring isolated isolation bases, provide double bell type rubber connectors.
5. 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.

2.07 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.

2.08 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.

2.09 BALANCING VALVES/FLOW METERS

A. Manufacturers:
1. Flow Design

2. Gerand
3. Griswold
4. Nexus
5. Tour & Anderson available through Victaulic Company of America
6. Substitutions: See Section 01 6000 - Product Requirements.

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.

E. Size 2-1/2 inch and Larger:
1. Provide ball or butterfly style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, or weld end connections.
2. Valve body construction materials consist of carbon steel or ductile iron.
3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, or NORYL.

2.10 AUTOMATIC FLOW CONTROL VALVES

A. Manufacturers:
1. Pro-Hydronics
2. Nexus
3. Griswold
4. Substitutions: See Section 01 6000 - Product Requirements.

B. Construction:
1. Brass, bronze, or iron body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
2. Built-in lug-type outlet butterfly valve with 2-position handle.

C. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.

D. Control Mechanism: Provide stainless steel or nickel-plated, brass piston or regulator cup, operating against stainless steel helical or wave formed spring or elastomeric diaphragm and polyphenylsulfone orifice plate.

E. Accessories: Provide inlet in-line strainer and outlet ball valve.

2.11 RELIEF VALVES

A. Manufacturers:
1. Apollo Valves; _____: www.apollovalves.com/#sle.
2. ITT Bell & Gossett: www.bellgossett.com.

3. Substitutions: See Section 01 6000 - Product Requirements.

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

PART 3 EXECUTION

3.01 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, heat exchangers, and expansion tanks.

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.

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.

3.02 MAINTENANCE

A. See Section 01 7000 - Execution Requirements for additional requirements relating to maintenance service.

B. Explain corrective actions to Owner's maintenance personnel in person.

END OF SECTION

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SECTION 23 2123 - HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Circulators.

B. End-suction pumps.

1.02 REFERENCE STANDARDS

A. UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

1.03 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 6000 - Product Requirements, for additional provisions.
   b. Extra Pump Seals: two (2) for each type and size of pump.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Armstrong Pumps Inc: www.armstrongpumps.com.

B. Bell & Gossett, a Xylem Inc. brand: www.bellgossett.com.

C. Grundfos Pumps Corporation; _____: www.grundfos.com/#sle.

D. Taco.

E. Substitutions: See Section 01 6000 - Product Requirements.

2.02 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. Variable Frequency Drives (VFDs): Provide in accordance with Section 23 0934, except for integral-VFDs.
3. Enclosures: Provide unspecified product(s) required to fit motor:

D. Pump shall be provided with an electronically commutated motor (ECM). Pump speed shall be based on (onboard variable speed control potentiometer allowing up to a 5/1 turndown for system balancing) (0-10V DC input from the building automation system for pump modulation).

E. 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.

2.03 CIRCULATORS

A. Horizontal shaft, single-stage pump with direct connected, resilient-mount, oil lubricated motor for discharge pressures of up to 125 psi.

B. Casing: Cast iron, with flanged pump connections.

C. Impeller: Bronze keyed to shaft.

D. Bearings: Permanently-lubricated ball bearings.

E. Shaft: Alloy steel with bronze sleeve, integral thrust collar.

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. Drive: Flexible coupling.

2.04 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: Bronze, 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

3.01 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 line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
F. Provide air cock and drain connection on horizontal pump casings.
G. Provide drains for bases and seals, piped to and discharging into floor drains.
H. 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.
I. Install base-mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 03 3000.
J. Lubricate pumps before start-up.
K. Provide side-stream filtration system for closed loop systems. Install across pump with flow from pump discharge to pump suction from pump tappings.
L. Controls Human-Machine Interface (HMI): HVAC operator terminal; see Section 25 3500.

END OF SECTION

SECTION 23 2213 - STEAM AND CONDENSATE HEATING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe and pipe fittings.
B. Pipe hangers and supports.
C. Steam piping system.
D. Steam condensate piping system.

1.02 REFERENCE STANDARDS

A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2016.
B. ASME B31.1 - Power Piping; 2022.
C. ASME B31.9 - Building Services Piping; 2020.
D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2020.
E. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2019.
F. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015, with Errata (2016).
G. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018.

1.03 SYSTEM DESCRIPTION

A. When more than one piping system material is selected, ensure systems components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.
B. Use unions and flanges downstream of valves and at equipment or apparatus connections. Use dielectric unions where joining dissimilar materials. Do not use direct welded or threaded connections.
C. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
D. Use gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
E. Use globe valves for throttling, bypass, or manual flow control services.

1.04 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 catalogue information. Indicate valve data and ratings.
    2. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
C. Closeout Documents:
    1. Project Record Documents: Record actual locations of valves.
    2. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the work of this section, with minimum five (5) years of documented experience.
B. Welder Qualifications: Certified in accordance with ASME BPVC-IX.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labelling 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

2.01 REGULATORY REQUIREMENTS

A. Comply with ASME B31.9 and ASME B31.1 code for installation of piping system.
B. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of welders.
C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.

2.02 LOW PRESSURE STEAM PIPING (15 PSIG MAXIMUM)

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.

1. Fittings: ASME B16.3 malleable iron Class 150, ASTM A420 or ASTM A234/A234M wrought steel.
2. Joints: Threaded, or AWS D1.1/D1.1M welded.

2.03 LOW PRESSURE STEAM CONDENSATE PIPING

A. Steel Pipe: ASTM A53/A53M, Schedule 80, black.
1. Fittings: ASME B16.3 malleable iron Class 150, or ASTM A234/A234M wrought steel.
2. Joints: Threaded, or AWS D1.1/D1.1M welded.

2.04 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

B. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Carbon steel, adjustable swivel, split ring.
C. Hangers for Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
D. Hangers for Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
E. Multiple or Trapeze Hangers for Pipe Sizes to 4 inches: Steel channels with welded spacers and hanger rods.
F. Multiple or Trapeze Hangers for Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods; cast iron roll and stand.
G. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
H. Wall Support for Pipe Sizes 4 to 5 Inches: Welded steel bracket and wrought steel clamp.
I. Wall Support for Pipe Sizes 6 Inches and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll.
J. Vertical Support: Steel riser clamp.
K. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
L. 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.

2.05 UNIONS, FLANGES, AND COUPLINGS

A. Unions for Pipe 2 Inches and Under:
1. Ferrous Piping: 150 psig galvanized malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe Over 2 Inches:
1. Ferrous Piping: 150 psig forged steel, slip-on.
2. Gaskets: 1/16 inch thick preformed non-asbestos graphite fiber.
3. Bolts to be B7 hardened stud bolts for both high & low pressure steam.

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

PART 3 EXECUTION

3.01 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.
D. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.
E. After completion, fill, clean, and treat systems. See Section 23 2500.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. All threaded joints shall be sealed with a multi-purpose thread sealant similar to Hercules Megaloc Thread Sealant. Sealant shall be rated for service from -50F to 400F. Sealant shall be non-toxic, non-hazardous, non-flammable, and contain no lead, heavy metals or volatile solvents.
C. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
D. Install piping to conserve building space and avoid interference with use of space.
E. Sleeve pipe passing through partitions, walls, and floors.
F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
G. Pipe Hangers and Supports:

1. Install in accordance with ASME B31.9.
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. 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. See Section 09 9123 Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

H. Provide clearance for installation of insulation and access to valves and fittings.

I. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 3100.

J. Slope steam piping one inch in 40 feet in direction of flow. Use eccentric reducers to maintain bottom of pipe level.

K. Slope steam condensate piping one inch in 40 feet. Provide drip trap assembly at low points and before control valves. Run condensate lines from trap to nearest condensate receiver. Provide loop vents over trapped sections.

L. Runouts of steam and condensate return to equipment shall pitch 1/2" to the foot. The runouts or sprig pieces shall be taken off the top of the main or at a 45 degree angle. Proper swing joints shall be provided for the expansion of all pipes.

M. Seal exterior wall penetrations above grade weather tight.

N. Install valves with stems upright or horizontal, not inverted.

3.03 TESTING

A. Piping shall be tested hydrostatically in accordance with latest edition of ASTM B31.1 and the following:
1. Pressure: 1-1/2 times working pressure but not less than 100 psi.
2. Duration: 15 minutes

3.04 SCHEDULES

A. Hanger Spacing for Copper Tubing.
1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.

B. Hanger Spacing for Steel Steam Piping.
1. 1/2 inch: Maximum span, 8 feet; minimum rod size, 1/4 inch.
2. 3/4 inch and 1 inch: Maximum span, 9 feet; minimum rod size, 1/4 inch.
3. 1-1/4 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
4. 1-1/2 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
5. 2 inches: Maximum span, 13 feet; minimum rod size, 3/8 inch.
6. 2-1/2 inches: Maximum span, 14 feet; minimum rod size, 3/8 inch.
7. 3 inches: Maximum span, 15 feet; minimum rod size, 3/8 inch.
8. 4 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. 6 inches: Maximum span, 21 feet; minimum rod size, 1/2 inch.
10. 8 inches: Maximum span, 24 feet; minimum rod size, 5/8 inch.
11. 10 inches: Maximum span, 26 feet; minimum rod size, 3/4 inch.
12. 12 inches: Maximum span, 30 feet; minimum rod size, 7/8 inch.

C. Hanger Spacing for Steel Steam Condensate Piping.
1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.

7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. 6 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. 8 inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
10. 10 inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.
11. 12 inches: Maximum span, 23 feet; minimum rod size, 7/8 inch.

END OF SECTION

SECTION 23 2214 - STEAM AND CONDENSATE HEATING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Steam traps.
B. Flash tanks.
C. Condensate pumps.
D. Positive displacement condensate pump
E. Pressure reducing valves.
F. Steam safety valves.
G. Control valves.
H. Steam condensate meters.

1.02 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023.
B. ASME B31.9 - Building Services Piping; 2020.
C. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings; 2004 (Reapproved 2023).
D. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).

1.03 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop Drawings:
    1. Product Data:
        a. Provide for manufactured products and assemblies required for this project.
        b. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
        c. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each specialty.
        d. Include electrical characteristics and connection requirements.
C. Closeout Documents:
    1. Manufacturer's Installation Instructions: Indicate application, selection, and hookup configuration. Include pipe and accessory elevations.
    2. Operation and Maintenance Data: Include installation instructions, servicing requirements, and recommended spare parts lists.

1.04 QUALITY ASSURANCE

A. Perform Work in accordance with State of _____ standard for installation of boilers and pressure vessels.
    1. Maintain one copy of each document on site.
B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose indicated.

PART 2 PRODUCTS

2.01 STEAM TRAPS

A. Manufacturers:
    1. Armstrong International, Inc: www.armstronginternational.com.
    2. Hoffman a xylem brand: www.bellgossett.com/hoffman-specialty-products/
    3. MEPCO: www.mepcollc.com
    4. Substitutions: See Section 01 6000 - Product Requirements.
B. Steam Trap Applications:
    1. Use Float and Thermostatic Traps for:
        a. Flash tanks.
        b. Direct steam injected equipment.
        c. Main headers.
C. Steam Trap Performance:
    1. Select to handle minimum of two times maximum condensate load of apparatus served.

2. Pressure Differentials:
    a. Low Pressure Systems (5 psi and less): 1/2 psi.

D. Inverted Bucket Steam Traps:
1. Cast iron body with integral strainer, blowdown valve, bolted cover, stainless steel internals including hardened valve and seat, internal check valve, thermic vent, and threaded pipe-end connections for pressures up to 250 psi and temperatures up to 450 degrees F.
2. Stainless steel body, bolted cover, stainless steel internals including hardened valve and seat, and threaded pipe-end connections for pressures up to 450 psi and temperatures up to 750 degrees F.

E. Float and Thermostatic Steam Traps:
1. Metal body with bolted cover, stainless steel or bronze bellows type thermostatic air vent, stainless steel or copper float, stainless steel lever valve assembly, bottom drain plug, and accessible to internal parts without disturbing piping.

F. Pressure Balanced Thermostatic Traps: ASTM A395/A395M cast iron body and bolted or screwed cover, and integral ball joint union for 125 psi WSP; phosphor bronze bellows, stainless steel valve and seat, integral stainless steel strainer.

2.02 FLASH TANKS

A. Manufacturers:
1. Armstrong International Inc; _____: www.armstronginternational.com/#sle.
2. Penn Separator Corporation; _____: www.pennseparator.com/#sle.
3. Wessels Company; _____: www.westank.com/#sle.
4. Substitutions: See Section 01 6000 - Product Requirements.

B. Tank: Closed type, welded steel construction, cleaned, prime coated, and supplied with steel support legs.
1. Tested and stamped in accordance with ASME BPVC-VIII-1.
2. Working Pressure: 100 psi.
3. Construct with nozzles and tappings for installation of accessories and piping connections.

2.03 CONDENSATE PUMPS

A. Pumps: Dual pump, vertical design, bronze fitted with stainless steel shaft, enclosed bronze impeller, renewable bronze case ring, mechanical shaft seal, close coupled to motor.

B. Receiver: Cast iron with capacity as scheduled.

C. Controls: Include control panel with mechanical alternator.

2.04 POSITIVE DISPLACEMENT CONDENSATE PUMP:

A. Furnish and install according to plans and manufacture's specifications the quantity of positive displacement pressure-powered pumps as shown on the drawings.

B. Unit shall be Armstrong Model PR-516 Pump Trap complete with:
1. 150 psig ASME labeled and coded steel horizontal pump tank
2. Float operated liquid level control having all moving parts in stainless steel
3. Liquid level gauge glass assembly having bronze hand valves and guard rods for receiver and pump tanks
4. Pressure reducing valve.
5. 4" stainless steel inlet check valve
6. 4" stainless steel outlet check valve
7. Removable insulation jackets for both tanks
8. Drain piping assembly

C. Above items assembled on a steel skid complete with schedule 40 pipe and fittings, and bronze isolation hand valve for fill line.

D. Provide stainless steel, spring loaded wafer check valves for inlet and outlet of condensate pump.

E. Acceptable manufacturers shall be Armstrong, Gastra, Johnson or approved equal.

2.05 DIRECT OPERATED PRESSURE REDUCING VALVES

A. Manufacturers:
1. Spence
2. Runkle
3. Substitutions: See Section 01 6000 - Product Requirements.

B. Steam pressure reducing valves shall have a cast iron body with flanged or screwed ends rated for 150% of inlet pressure, bronze diaphragm, replaceable seat rings and disks, stainless steel stems and carbon steel main springs, with pressure pilot having (3) to (20) psi adjustable springs. Steam pressure reducing valves shall be suitable for dead end service.
C. Installation of pressure reducing valve station shall include steam pressure gauge on low pressure side of valve, pipe reducers, increasers, strainers, and all pilot valve piping. Provide gate valves ahead of, and on leaving side of each station, and a by-pass with globe valve around each station.
D. Provide with orifice plate for sound suppression.
E. Valve capacities shall be as scheduled on the drawings.
F. End Connections: Female thread for sizes 2 inch and smaller, otherwise flanged.
G. Operating Pressure Range: 15 to 250 psi with 15 psi differential.

2.06 PILOT OPERATED STEAM PRESSURE REDUCING VALVES

A. Manufacturers:
   1. Spence
   2. Kunkle
B. Steam pressure reducing valves shall have a cast iron body with flanged or screwed ends rated for 150% of inlet pressure, bronze diaphragm, replaceable seat rings and disks, stainless steel stems and carbon steel main springs, with pressure pilot having (3) to (20) psi adjustable springs. Steam pressure reducing valves shall be suitable for dead end service.
C. Installation of pressure reducing valve station shall include steam pressure gauge on low pressure side of valve, pipe reducers, increasers, strainers, and all pilot valve piping. Provide gate valves ahead of, and on leaving side of each station, and a by-pass with globe valve around each station.
D. Provide with orifice plate for sound suppression.
E. Valve capacities shall be as scheduled on the drawings.

2.07 SAFETY RELIEF VALVES

A. Manufacturers:
   1. Armstrong International, Inc; _____: www.armstronginternational.com/#sle.
   2. ITT McDonnell & Miller, a xylem brand: www.mcdonnellmiller.com.
   3. Kunkle
   4. Substitutions: See Section 01 6000 - Product Requirements.
B. Valve: Cast iron body, stainless steel valve spring, stem, and trim, direct pressure actuated, capacities ASME certified and labelled.
C. Accessories: Drip pan elbow.

2.08 CONDUCTIVITY METERS

A. Provide ABB model TB26-010111000332 with a 3/4" NPS male connection or approved equal. The remote conductivity meter reader shall be an ABB model AX400 or approved equal. Conductivity meter to be included in building automation system.

2.09 STEAM CONDENSATE METERS

A. Provide ABB Magnetic Flowmeter model FEM325025E1D0W1Y1A1A0P1BOY1AYF6M5 on pumped condensate line or approved equal. Final location shall be approved by owner. Remote flowmeter reader shall be ABB model FET3251A0P1B3C0H2 or approved equal. Flowmeter shall be included in building automation system.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install steam and steam condensate piping and specialties in accordance with ASME B31.9.
B. Install specialties in accordance with manufacturer's instructions.
C. Steam Traps:
   1. Provide minimum 3/4 inch size on steam mains and branches.
   2. Install with union or flanged connections at both ends.
   3. Provide gate valve and strainer at inlet, and gate valve and check valve at discharge.
   4. Provide minimum 10 inch long, line size dirt pocket between apparatus and trap.
D. Remove thermostatic elements from steam traps during temporary and trial usage, and until system has been operated and dirt pockets cleaned of sediment and scale.

E. Provide pressure reducing stations with pressure reducing valve, valved bypass, strainer and pressure gauge on upstream side, relief valve and pressure gauge on downstream side of pressure reducing valve.
   1. Pressure reducing station shall be one or two stages as required, to produce flat reduced pressure curve over range of capacity.
   2. Locate pilot operator control minimum 6 feet downstream of valve.
F. Rate relief valves for pressure upstream of pressure reducing station, for full operating capacity. Set relief at maximum 20 percent above reduced pressure.
G. Terminate relief valves to outdoors. Provide drip pan elbow with drain connection to nearest floor drain.
H. Condensate meter(s) shall be furnished by the automatic temperature controls contractor. The mechanical contractor shall install condensate meter in coordination with the DDC contractor.
I. When several relief valve vents are connected to a common header, header cross section area shall equal sum of individual vent outlet areas.

END OF SECTION

SECTION 23 2500 - HVAC WATER TREATMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Materials.
   1. System cleaner.
   2. Closed system treatment (water).
B. By-pass (pot) feeder.
C. Glycol Equipment and Glycol
D. Side-stream filtration equipment.
E. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; 2021.

1.02 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 6000 - Product Requirements, for additional provisions.
      b. Sufficient chemicals for treatment and testing during required maintenance period.

1.03 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.

1.04 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

2.01 MANUFACTURERS

2.02 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
   5. Biocide chlorine release agents such as sodium hypochlorite or calcium hypochlorite or microbiocides such as quarternary ammonia compounds, tributyltin oxide, methylene bis (thiocyanate).
B. Closed System Treatment (Water):
   1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.

2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
3. Conductivity enhancers; phosphates or phosphonates.

2.03 BY-PASS (POT) FEEDER

A. Manufacturers:
1. Neptune, a brand of the Dover Company; DBF-2HP: www.neptune1.com.
2. Substitutions: See Section 01 6000 - Product Requirements.

B. 2 gallon steel tank with working pressure of 150 psi. Feeder to have 3-1/2" fill opening with 3/4" NPT inlet and outlet connections. The fill cover opening cover shall be self aligning and shall not allow removal under pressure.

2.04 SIDE STREAM FILTER

A. Shall be constructed and stamped in accordance with ASME BPVC-IV, 100 PSI rating.

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 30 micron with metal core and shall be rated for use in 30°F to 210°F fluids containing up to 40% 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.

2.05 GLYCOL MAKE-UP TANK

A. Drum shall be 55 gallons and mixed to proper concentration of system. See drawings for drum connection locations.

2.06 GLYCOL FILL PUMP

A. Portable utility pump shall be manufactured by Dayton, Barracuda, or equal. 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.

2.07 GLYCOL SOLUTION

A. Manufacturers
1. Dow Chemical model Dowtherm SR-1 or Freemont 9134.
2. If expanding existing system, match existing glycol product.
3. Substitutions: See Section 01 6000 - Product Requirements.

B. Type - Inhibited Ethylene

C. Glycol Solution:
1. Heating Hot Water: Inhibited glycol and water solution mixed 40 percent glycol - 60 percent water, suitable for operating temperatures from minus 30 degrees F to 210 degrees F.
2. Chilled Water: Inhibited glycol and water solution mixed 40 percent glycol - 60 percent water, suitable for operating temperatures from minus 30 degrees F to 210 degrees F.

PART 3 EXECUTION

3.01 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 2500.

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.

3.02 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. The entire new and existing hot water heating and chilled water cooling 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.
D. 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 and existing hot water heating and chilled water cooling system shall be refilled with water, corrosion inhibitors installed, all air vented out and the system placed in operation.
E. 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.
F. 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.
G. During all flushing, system fluid temperatures shall not exceed recommended temperatures from the pre-treatment suppliers recommendations.
H. 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 and chilled water piping circuit shall be refilled with water-glycol solution containing corrosion inhibitors, all air vented out, and the system placed in operation.
I. 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.
J. 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.
K. All hot water and chilled water systems including glycol systems shall have corrosion inhibitors provided and installed after final cleaning.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Provide concrete housekeeping pad for floor mounted equipment and tanks.

3.04 CLOSED SYSTEM TREATMENT

A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
B. Introduce closed system treatment through bypass feeder when required or indicated by test.
C. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

3.05 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 40% (+/- 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 burst protection temperature of -35°F.
C. (The new cooling coil piping circuit shall be filled with a 40% (+/- 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 burst protection temperature of -35°F.)

D. 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 40% solution of Dowtherm SR-1 (Dowfrost HD) and water. The solution should be tested each year for freezing protection and corrosion inhibitor."

E. 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.

F. All glycol shall have surfactants and dispersants included in the inhibitor package of the glycol.

G. 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.

3.06 CLOSEOUT ACTIVITIES

A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.
   1. Provide minimum of two hours of instruction for two people.
   2. Have operation and maintenance data prepared and available for review during training.
   3. Conduct training using actual equipment after treated system has been put into full operation.

3.07 MAINTENANCE

A. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the equipment manufacturer or original installer.

B. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of Owner.

C. Provide service and maintenance of treatment systems for one year from Date of Substantial Completion.

D. Provide monthly technical service visits to perform field inspections and make water analysis on-site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.

E. Provide laboratory and technical assistance services during this maintenance period.

F. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

END OF SECTION

SECTION 23 3100 - HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal ducts.
B. Flexible ducts.
C. Ducts for laboratory and industrial-grade applications.

1.02 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. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
D. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; 2012.

1.03 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.

1.04 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.

1.05 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

2.01 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 3319.
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. Return and Relief: 2 in-wc, galvanized steel
    4. General Exhaust: 2 in-wc, galvanized steel
    5. Outside Air Intake: 2 in-wc, galvanized steel
    6. Transfer Air and Sound Boots: 1 in-wc, galvanized steel
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.

2.02 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 ductwork. System shall be similar to Ductmate Clutcher 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.

2.03 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.
    b. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 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.

2.05 DUCTS FOR LABORATORY AND INDUSTRIAL-GRADE APPLICATIONS

A. Ductwork and fittings shall be constructed and supported in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible (latest edition) except as modified herein.

B. Ductwork and fittings shall be fabricated from stainless steel sheet, ASTM A167, Class 302 or 304, Condition A (annealed) Finish No. 4 for exposed ducts and Finish No. 2B for concealed duct or ducts located in mechanical rooms.

1. Ducts shall conform to dimensions on the drawings unless location of structural members prohibit. In case of a change in dimension, cross-sectional areas shall be maintained. All ducts shall be straight and smooth on the inside with finished joints. All ducts shall be complete in themselves. No single thickness partitions shall be allowed between ducts.

C. Ducts shall be constructed and reinforced to meet or exceed the pressure classes listed in the following table.

DUCT INVOLVED	Pressure (inches w.g.)
from Fume Hood to VAV Terminal Units	1"
From VAV Terminal Units to Exhaust Fan	4"
from Exhaust Fan to Louver/Roof Hood	4"

D. All laboratory exhaust ductwork shall be constructed of a minimum 20 gauge stainless steel that is welded air and water tight. Ductwork shall be fabricated such that no joint connection extends into the air stream. A single flanged joint shall be allowed for connection to terminal equipment and exhaust fan.

E. 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.

PART 3 EXECUTION

3.01 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. 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..

F. Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.

G. 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.

H. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

I. Use double nuts and lock washers on threaded rod supports.

J. 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.

K. 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.

L. Testing and Adjusting

1. The supply, return and exhaust 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 0593 - Testing, Adjusting, and Balancing for HVAC of these specifications for more information.

END OF SECTION

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SECTION 23 3300 - AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Backdraft dampers - metal.
B. Combination fire and smoke dampers.
C. Duct access doors.
D. Duct test holes.
E. Fire dampers.
F. Volume control dampers.
G. Motor Operated Dampers
H. Miscellaneous products:
    1. Internal strut end plugs.
    2. Duct opening closure film.

1.02 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
B. NFPA 92 - Standard for Smoke Control Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
D. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.
E. UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.

1.03 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 6000 - 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.

1.04 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.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 BACKDRAFT DAMPERS - METAL

A. Manufacturers:
    1. Nailor Industries, Inc: www.nailor.com.
    2. Ruskin Company, a brand of Johnson Controls: www.ruskin.com.
    3. Greenheck: www.greenheck.com
    4. Loren Cook: www.lorencook.com
    5. Pottorf: www.pottorf.com
    6. Substitutions: See Section 01 6000 - Product Requirements.
B. Gravity Backdraft Dampers, Size 18 by 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.
C. 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.

D. 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.
E. The mechanical contractor shall work with the testing and balancing contractor to insure the dampers are adjusted during balancing to properly control building pressurization.
F. Spring type dampers will not be allowed.
G. 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.

2.02 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
   1. Nailor Industries, Inc: www.nailor.com.
   2. Ruskin Company, a brand of Johnson Controls: www.ruskin.com.
   3. Greenheck: www.greenheck.com
   4. Pottorf: www.pottorf.com
   5. Substitutions: See Section 01 6000 - Product Requirements.
B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
C. Provide factory sleeve and collar for each damper. Sleeve shall extend a minimum of six (6) inches on either side of the wall. Sleeve shall be furnished with metal thickness in accordance with UL 555.
D. Multiple Blade Dampers: Fabricate with 16 gage, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, blade edge seals of silicone rubber, and lock, and 1/2 inch actuator shaft.
E. Motors for operation of fire/smoke dampers shall be spring return, normally closed type, 120V and shall be furnished complete with damper linkage, etc., by the damper manufacturer.
F. Damper shall be furnished with a two-position indicator switch linked to the damper blades to provide remote indication of damper position.
G. Out of wall" fire/smoke dampers where required shall be furnished with thermal blanket around the sleeve. All thermal insulating blankets shall be a part of an approved assembly.
H. Electro Thermal Link: Fusible link melting at 165 degrees F; line or low voltage coordinated with fire alarm; UL listed and labeled. Upon detection, device shall close and lock damper during test, smoke detection, power failure or fire conditions through the actuator closure spring. At no time shall the actuator disengage from the damper blades. Device shall allow damper to be manually reset after test, smoke detection or power failure conditions.
I. Fire/smoke dampers shall be installed with access panel located in ductwork on both sides of wall arranged to provide access to fusible link, actuator and blades for servicing.
J. Installation of fire/smoke dampers shall be in accordance with latest edition of the SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems.
K. All combination fire/smoke dampers shall be tested by the contractor to insure proper operation without binding. The contractor shall prepare a written report listing each installed device, location, system served and date tested and shall indicated the damper that the operating correctly. This report shall be included in the Operation and Maintenance Manual.

2.03 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
8. Substitutions: See Section 01 6000 - Product Requirements.

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, 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.

2.04 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.
b. Substitutions: See Section 01 6000 - Product Requirements.

2.05 FIRE DAMPERS

A. Manufacturers:
1. Nailor Industries, Inc: www.nailor.com.
2. Ruskin Company, a brand of Johnson Controls: www.ruskin.com.
3. Pottorf: www.pottorf.com
4. Air Balance: www.airbalance.com
5. Greenheck: www.greenheck.com
6. Aire Technologies:www.airetechnologies.com
7. Substitutions: See Section 01 6000 - Product Requirements.

B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated. Dampers shall be 1-½ hour rated unless otherwise noted on the drawings as 3 hour rated. Installation of fire dampers shall be in accordance with latest edition of the SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems.

C. Horizontal or Vertical Dampers: Galvanized steel, 22 gage, 0.0299 inch frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.

D. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations or vertical installations. Configure with blades out of air stream except for 1.0 inch pressure class ducts up to 12 inches in height.

E. Dampers shall be furnished with galvanized steel sleeve that extends a minimum of six (6) inches on either side of the wall. Sleeve shall be furnished with metal thickness in accordance with UL 555.

F. Multiple Blade Dampers: 16-gauge, 0.0598-inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

G. Fire dampers shall be installed with access panel located in ductwork arranged to provide access to fusible link and blades for servicing.

H. Fusible Links: UL 33, separate at 165 degrees F with adjustable link straps for combination fire/balancing dampers.

2.06 VOLUME CONTROL DAMPERS

A. Manufacturers:
   1. Nailor Industries, Inc: www.nailor.com.
   2. Ruskin Company, a brand of Johnson Controls: www.ruskin.com.
   3. Aire Technologies: www.airetechnologies.com
   4. Greenheck: www.greenheck.com
   5. Substitutions: See Section 01 6000 - Product Requirements.

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.
      c. Substitutions: See Section 01 6000 - Product Requirements.

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.
      b. Substitutions: See Section 01 6000 - Product Requirements.

2.07 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. Louver blade dampers
   1. Dampers shall be louver blade type, factory fabricated and with factory assembled linkages. Blades shall have interlocking edges or shall be provided with compressible seals at point of contact. Damper blades shall have steel trunnions mounted in bronze sleeve, nylon or ball bearings. Dampers shall be not be 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 20 cfm per square foot at 4 inches water gauge static pressure. Dampers shall be installed with operators having sufficient power to limit leakage to the rate specified. Dampers shall have bar or channel frames, and all parts of dampers shall be factory finished with two coats of rust inhibitive paint or shall be zinc coated.
   2. Acceptable manufacturers shall be Ruskin, Greenheck, National Controlled Air, Safe Air, Vent Products, Cesco, Nailor, Tamco or an approved equal.

C. Airfoil blade dampers
   1. Dampers shall be airfoil blade type, factory fabricated and with factory assembled linkages. Blades shall have overlapping edges (not just overlap seals) with compressible seals at points of contact. 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. 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 10 cfm per square foot at 4 inches water gauge static pressure. Dampers shall be installed with operators having sufficient power to limit leakage to the rate specified. Dampers shall have bar or channel frames, and all parts of dampers shall be minimum of 12 Gauge extruded aluminum.
   2. Acceptable manufacturers shall be Arrow, Cesco, Greenheck, Nailor, Ruskin, Tamco or an approved equal.

2.08 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. Substitutions: See Section 01 6000 - Product Requirements.

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.
      b. Substitutions: See Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). See Section 23 3100 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, at fire dampers, combination fire and smoke 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. Provide fire dampers and combination fire and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

F. Provide identification of access doors for Fire Dampers and Combination Fire/Smoke Dampers.

G. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
H. Demonstrate re-setting of fire dampers to Owner's representative.
I. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
J. 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.
K. Use splitter dampers only where indicated.
L. Provide balancing dampers on high velocity systems where indicated. See Section 23 3600.
M. 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.
N. Provide balancing dampers on all takeoffs serving terminal devices.

END OF SECTION

SECTION 23 3423 - HVAC POWER VENTILATORS AND EXHAUST SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof exhausters.
B. Ceiling exhaust fans.
C. Utility vent blower sets.
D. Laboratory-fume exhaust fans.

1.02 REFERENCE STANDARDS

A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
B. AMCA 99 - Standards Handbook; 2016.
C. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2020.
D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2016, with Errata (2018).
E. AMCA 211 - Certified Ratings Program Product Rating Manual for Fan Air Performance; 2022, with Editorial Revision (2023).
F. AMCA 260 - Laboratory Methods of Testing Induced Flow Fans for Rating; 2020.
G. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; 2014.
H. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.
I. AMCA 311 - Certified Ratings Program Product Rating Manual for Fan Sound Performance; 2016.
J. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
K. NFPA 45 - Standard on Fire Protection for Laboratories Using Chemicals; 2019.
L. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
M. NFPA 91 - Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids; 2020.
N. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.
O. UL 705 - Power Ventilators; Current Edition, Including All Revisions.

1.03 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 6000 - Product Requirements, for additional provisions.
        b. Extra Fan Belts: One set for each individual fan.

1.04 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

2.01 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.
D. Substitutions: See Section 01 6000 - Product Requirements.

2.02 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 250.
H. Provide fans sized with maximum RPM at 10% above scheduled RPM.

2.03 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-12 insulation.
C. Disconnect Switch: Factory wired, nonfusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.
D. Motorized Damper: motorized actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linke, and line voltage motor drive, power open, spring return.
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.

2.04 CEILING EXHAUST FANS

A. Centrifugal Fan Unit: V-belt or 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. Furnish with each fan a wall/roof cap termination per the manufacturer's instructions.
E. Disconnect Switch: Cord and plug in housing for thermal overload protected motor.
F. Grille: Molded white plastic.
G. 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.

2.05 UTILITY VENT BLOWER SETS

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 250: 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. Roof Curb: 12 inch high; self-flashing of galvanized steel with continuously welded seams, built-in cant strips, insulation and curb bottom, curb bottom, factory installed nailer strip, 1-1/2-inch thick insulation with 3 lb. density, and curb cap inlet box with access door.

F. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

G. Options/Accessories:
1. Access door for inspection of fan wheel.
2. Inlet screen.
3. Weather hood.
4. Roof Curb Extension: Vented curb extension where required for compliance with minimum clearances required by NFPA 96.
5. Dampers: Provide gravity type.
6. Finishes: Factory primed.
7. Heat Baffle: Prevents heat from radiating into motor compartment.

2.06 LABORATORY FUME-EXHAUST FANS

A. General Requirements:
1. Fan Type: Roof-curb mounted, diluted high-plume laboratory exhaust.
2. Provide fan-assembly manufactured to sustain structural integrity without external guy-wires or supplemental supports at wind speeds up to 125 mph.
3. Fan performance tested in accordance with AMCA 210, AMCA 260, and AMCA 300.
4. Fan performance ratings certified in accordance with AMCA 211 and AMCA 311.
5. Comply with NFPA 90A and NFPA 91 requirements for chemical laboratory applications per NFPA 45.

B. Application:

C. Fan Section Requirements:
1. Impeller:
a. Non-overloading, backward-inclined centrifugal.
b. Material: Aluminum.
2. Fan Shaft:
a. Ground and polished steel with anticorrosive coating.
b. First critical speed at least 25 percent over maximum cataloged operating speed.
c. Enclosed over OSHA recommended safety-yellow painted guards.
3. Bearings:
a. 100 percent factory tested surface-mounted bearings outside of the airstream.

b. Operate during a minimum L10 service life in excess of 100,000 hours at maximum cataloged operating speed.

4. Belt-drive Assembly:
   a. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
   b. Belts: Static-free and oil resistant.
   c. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
   d. Motor pulley adjustable for final system balancing, readily accessible for maintenance.
5. Housing:
   a. Construct of heavy gauge aluminum with standard factory finish.
   b. Mounting Base:
   c. Construct drive frame assembly of heavy gauge steel, mounted on vibration isolators.
   d. Provide breather tube for fresh air motor cooling and wiring.
   e. Minimum Assembly Height: 120 inches above the roof surface.
6. Isolation Damper:
   a. With parallel blade damper, constructed of matching materials and finish.
   b. Provided by manufacturer, bolted to access drawer or panel for easy removal from contaminated airstream.
   c. With two-position damper actuator:
      1) Provided by manufacturer.
      2) Operate interlocked with fan starter.
      3) With integral auxiliary switches to monitor blade position status.
      4) Rated for NEMA 250, Type 4 (IP66) environment within protective weather-housing out of contaminated airstream, connected through linkages.
7. Fan Discharge Outlet-Nozzle:
8. Fan Inlet Flow Sensor: Provide factory-mounted pitot tube-based differential pressure sensor probe ready for connection into differential pressure-based flow transmitter.
   a. Transmitter Housing: Provide NEMA 250, Type 4 enclosure.

D. Disconnect Switch:
   1. Factory-mounted in NEMA 250, Type 3R box wired in compliance with Section 26 0583.
E. Roof Curbs:
   1. 24 inch high flanged, self-flashing of matching material and finish with continuously welded seams.
   2. Provide integral formed steel support framework with curb cap guides.

2.07 CARBON MONOXIDE/NITROGEN DIOXIDE SENSOR:

A. Carbon monoxide/Nitrogen dioxide control system shall consist of a control panel, which contains a power supply, clocks, visual display of gas concentration, audible and visual alarms, delays, relays, one carbon monoxide sensor, and one nitrogen dioxide sensor, and shall be UL 2075 listed.

B. Switches shall be provided for field adjustment of the gas detection level for the low-alert, and of the on/off time delay for the low-alert and high-alert. Selectable CO detection levels shall range from 20 to 55 ppm and the NO2 detection levels shall range from 0.3 to 4.0 ppm. Selectable time delays shall range from 0 to 7 minutes, in 1 minute increments.

C. The control system shall have two levels of control. At low alert 20 ppm CO or 0.3 ppm NO2 the exhaust and make-up air system relays shall be energized. The system shall remain energized until the level drops below the setpoint. If the concentration levels increase while the ventilation system is in operation, at the high level point, the audio and visual alarm shall sound. If the concentration level drops back below the first alarm setting without exceeding the second alarm level the first level alarm shall reset itself. The second level alarm shall require manual reset. The concentration levels shall be user adjustable.

D. An external push button on the front of the enclosure shall be provided to silence the internal alarm. The alarm circuit shall become active again, once the detector is no longer at alarm levels.

E. The control panel shall contain the following items on the panel face: power "on" light, remote sensor power "on" lights, fan "on" light, dual level alarm "on" light, alarm "silence" switch, and all necessary displays and keypads to set warning and alarm levels and a LCD display indicating carbon monoxide level. Alarm panel shall be provided with manual by-pass to permit use of make-up air and exhaust manually.

F. Carbon monoxide (CO) sensor shall be mounted at 5′-0″ above finished floor. Controller shall be mounted at the same height. Nitrogen dioxide (NO2) sensor shall be mounted 12″ below the roof structure.
G. The equipment manufacturer shall provide the on-site services of a factory technician to train designated personnel in sensor maintenance, calibration and troubleshooting.
H. All electrical work required to interconnect multiple controllers shall be done by this contract. It shall be this contractor's responsibility to coordinate and provide the appropriate information to the electrician so that the system will be operational.
I. The exhaust fan and make-up air motorized damper shall be interlocked by this contractor to operate in unison on call from the control system.
J. Acceptable manufacturers shall be EIT, Honeywell, Brasch, National Draeger or an approved equal.

PART 3 EXECUTION

3.01 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

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SECTION 23 3513 - DUST COLLECTION SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Industrial dust collector and exhaust fan.
B. Welding Fume Extractor.
C. Ductwork and duct fittings.
D. Inlet fittings.
E. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 23 0513 - Common Motor Requirements for HVAC Equipment: Fan motors.
B. Section 23 0548 - Vibration and Seismic Controls for HVAC: Vibration isolators.

1.03 REFERENCE STANDARDS

A. ACGIH (IV) - Industrial Ventilation: A Manual of Recommended Practice for Design, 31st Edition; 2023, with Errata (2024).
B. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
C. AMCA 99 - Standards Handbook; 2016.
D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2016, with Errata (2018).
E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; 2014.
F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.
G. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2017.
H. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2023.
I. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2017.
J. AWS D9.1/D9.1M - Sheet Metal Welding Code; 2018.
K. NFPA 91 - Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids; 2020.
L. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
M. SMACNA (RIDC) - Rectangular Industrial Duct Construction Standards; 2007.
N. SMACNA (ROUND) - Round Industrial Duct Construction Standards; 2013.
O. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Shop Drawings:
    1. Indicate dimensions, sizes, weights and point loadings, material thickness, and locations and sizes of field connections. Submit construction layout and details for inlet fittings.
    2. Product Data: Provide manufacturers literature and data indicating rated capacities, dimensions, weights and point loadings, accessories, electrical characteristics and connection requirements, wiring diagrams, and location and sizes of field connections.
    3. Provide fan curves with specified operating point clearly plotted.
    4. Submit sound power levels for both fan inlet and outlet at rated capacity.
C. Closeout Documents:
    1. Manufacturer's Installation Instructions: Indicate assembly and installation instructions.
    2. Operation and Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 QUALITY ASSURANCE

A. Fans:
    1. Performance Ratings: Comply with AMCA 210 and bear the AMCA Certified Rating Seal.
    2. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
    3. Fabrication: Comply with AMCA 99.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 INDUSTRIAL DUST COLLECTOR AND EXHAUST FAN

A. Base performance on sea level conditions.

B. Dust Collector:
   1. Enclosureless shaker type dust collector.
   2. 450 square feet of 8 oz polyester glazed filters for minimal dust adherence, 95-98% efficiency at 5-10 microns. Air to cloth ratio of 8.2/1.
   3. Four (4) open sides structure for clean air recirculation.
   4. 0.75 HP motor for shaker cleaning action.
   5. Reinforced and braced support structure with rust resistant primer and final powder coat paint.
   6. 10 and 12 gauge painted steel frame with cross braces.
   7. One 30 gallon drum for dust containment, spare drum and dolly on casters included.
   8. Steep angled hopper from filter cabinet to drum.
   9. Slide ramp with clamp attachment from drum cover to hopper.
   10. Dust level sensor model SUB-040-ASLSLD03 with contact to main control panel.

C. Exhaust Fan:
   1. See schedule for performance, motor, and electrical characteristics.
   2. AMCA type B aluminum spark proof fan as required per NFPA.
   3. 13" slip fit inlet for ductwork attachment.
   4. Flanged outlet for direct mount to dust collector inlet.
   5. Painted steel housing with adjustable support legs.
   6. Rubber pad vibration isolators.

D. Magnetic Starter:
   1. Regular magnetic starter with NEMA 4/12 enclosure, timers for filter shaker action, overload protection, pilot light, fault light, step down transformer, reset, safety disconnect, auxiliary contact for drum dust level sensor.

E. Accessories:
   1. Fixed Inlet Vanes: Steel construction with fixed cantilevered inlet guide vanes welded to inlet bell.
   2. Adjustable Inlet Vanes: Steel construction with blades supported at both ends with two permanently lubricated bearings, variable mechanism out of air steam terminating in single control lever with control shaft for double width fans and locking quadrant.
   3. Discharge Dampers: Parallel blade heavy duty steel damper assembly with blades constructed of two plates formed around and welded to shaft, channel frame, sealed ball bearings, with blades linked out of air stream to single control lever.
   4. Inlet/Outlet Screens: Galvanized steel welded grid.

2.02 WELDING FUME EXTRACTOR AND ACCESSORIES

A. Manufacturers:
   1. Plymovent, Eurovac, or approved equal.

B. Filtration System:
   1. Two (2) high efficiency MERV 15 cartridges.
   2. Automatic pulse cleaning system with air tank.
   3. 3 HP 460V direct drive fan, 1400 CFM @ 6'' s,p. TEFC motor.
   4. 10 gauge reinforced painted steel frame, acid wash and final powder coat paint for maximum rust protection.
   5. Swing out acces door to cartridges and components.
   6. Final high-capacity HEPA filter.
   7. Sound insulated rear chamber.
   8. Welded lifting lugs at each corner and middle of the vessel included.
   9. Lift lugs and brackets for wall mount option.
   10. Clean out drawer, rear clean air outlet diffuser.

11. Washable/removable aluminum spark trap filter, air regulator included.
12. Two (2) flanged inlets for fume arm attachment (remote arms connected by field supplied ductwork).

C. Fume Arms:
1. 6" x 10' or 13' fume arms as indicated.
2. Cast aluminum adjustable arm joints.
3. 13'' painted aluminum capture hood with diverter to increase face velocity.
4. 26 gauge painted steel tubes for minimal friction loss.
5. Spark resistant flexible hose at arm joints.
6. Vacuum damper with adjustable exterior handle.
7. Threaded and greased arm socket for proper rotation.
8. Painted steel 11 gauge arm support bracket with duct companion flange.

D. Controls:
1. Regular NEMA 4X starter with on/off functions.
2. Reset, fault light, run light.
3. Adjustable timers for pulse cleaning system.
4. Overload protection, step down transformer.
5. Panel shipped loose for installation at proper location.

2.03 DUCTWORK AND DUCT ACCESSORIES

A. Materials:
1. Galvanized Steel Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M, FS Type B, with G90/Z275 coating.
a. Thickness: Base sheet steel, 24 gauge, 0.0239 inch minimum.
b. Thickness: As indicated on drawings.
2. Steel Ducts: ASTM A1011/A1011M, Designation CS, Type B carbon steel, 24 gauge, 0.0239 inch minimum thickness.
3. Stainless Steel Ducts: ASTM A666, Type 304, 26 gauge, 0.0187 inch minimum thickness.

B. Ductwork:
1. Fabricate and Support to UL 181 in Accordance With:
a. SMACNA (ROUND) and SMACNA (RIDC).
2. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline.
3. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
4. Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA (ROUND). Prime coat welded joints.
5. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow, with liquid adhesive plus sheet metal screws.
6. Joints: Minimum 4 inch cemented slip type, brazed, or electric welded to comply with AWS D9.1/D9.1M.
7. Provide standard 45-degree lateral wye branch fittings unless otherwise indicated.
8. Use double nuts and lock washers on threaded rod supports.

C. Flexible Connectors: UL listed, fire-retardant chloroprene or chlorosulfonated polyethylene impregnated fabric, minimum density 20 oz per sq yd, approximately 2 inches wide, crimped into metal edging strip.

D. Angle Rings: Carbon steel, unpainted, leg out, drilled with bolt holes.

E. Blast Gates: Half collar of cast aluminum, with galvanized steel slide, set screw.

F. Flat Back Elbows: Long radius rectangular elbow at duct material with heavy gauge, removable, stainless steel back strip.

G. Ball Joints: Cast iron with tubular studs for connecting ducts, allowing 25 degree angle off center.

2.04 INLET FITTINGS

A. Fabricate from 16 gauge, 0.0598 inch galvanized steel, minimum base sheet thickness.

B. Fabricate with hemmed edges, closed corners, and reinforced for span and attachment; with duct connection; prime coated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

3.02 INSTALLATION

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

B. Install in accordance with NFPA 91, SMACNA (DCS), SMACNA (ROUND), SMACNA (RIDC), and ACGIH (IV) except as indicated.

C. Do not operate fans for any purpose until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

D. Install fans with resilient mountings and flexible electrical leads. See Section 23 0548.

E. Install flexible connections at fan inlet and discharge. Ensure metal bands of connectors are parallel with minimum 1-inch flex between ductwork and fan while running.

F. Provide pitot tube openings where required for testing of systems, complete with metal cap with spring device or screw to ensure against air leakage.

G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

END OF SECTION

SECTION 23 3516 - ENGINE EXHAUST SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Centrifugal fans.
B. Ductwork and duct accessories.
C. Exhaust system accessories.

1.02 RELATED REQUIREMENTS

A. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment: Vibration isolators.
B. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
B. AMCA 99 - Standards Handbook; 2016.
C. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2016, with Errata (2018).
D. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; 2014.
E. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.
F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2017.
G. SMACNA (RIDC) - Rectangular Industrial Duct Construction Standards; 2007.
H. SMACNA (ROUND) - Round Industrial Duct Construction Standards; 2013.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Shop Drawings:
    1. Product Data: Provide manufacturers literature and data sheets indicating rated capacities, dimensions, weights and point loadings, accessories, electrical characteristics and connection requirements, wiring diagrams, and location and sizes of field connections.
    2. Provide fan curves with specified operating point clearly plotted.
    3. Submit sound power levels for both fan inlet and outlet at rated capacity.
    4. Shop Drawings: Indicate dimensions, sizes, weights and point loadings, and locations and sizes of field connections.
C. Closeout Documents:
    1. Manufacturer's Installation Instructions: Include assembly and installation instructions.
    2. Operation and Maintenance Data: Include instructions for fan lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 QUALITY ASSURANCE

A. Fan Performance Ratings: Determined in accordance with AMCA 210 and labeled with AMCA Certified Rating Seal.
B. Fan Sound Ratings: AMCA 301, tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.
C. Fan Fabrication: Comply with AMCA 99.
D. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
E. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 FIELD CONDITIONS

A. Permanent exhaust system may not be used for ventilation during construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Car-Mon Products Inc: www.car-mon.com.
B. Monoxivent: www.monoxivent.com/#sle.
C. Substitutions: See Section 01 6000 - Product Requirements.

2.02 CENTRIFUGAL FANS

A. Base performance on sea level conditions.

B. Performance:
   1. Refer to Fan Schedule.
C. Wheel and Inlet: Steel construction with smooth curved inlet flange, heavy back plate, backwardly curved blades welded to flange and back plate; cast iron hub riveted to back plate and keyed to shaft with set screws.
D. Housing: Heavy gage steel, spot welded with inlet bell and shaped cut-off, factory finished with enamel or prime coat.
E. Motors and Drives:
   1. Motors: As indicated, in compliance with Section 23 0513.
   2. Electrical Characteristics: Refer to Fan Schedule.
   3. Bearings: Heavy duty pillow block type, self-aligning, grease-lubricated ball bearings or roller bearings.
   4. Shafts: Hot rolled steel, ground and polished, with key-way, protectively coated with lubricating oil.
   5. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, keyed, variable and adjustable pitch, matched belts, and rated minimum 1.5 times nameplate rating of motor.
   6. Belt Guard: Fabricate to SMACNA (DCS); of 12 gage, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated.

2.03 DUCTWORK AND DUCT ACCESSORIES

A. Materials:
   1. Galvanized Steel Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.
B. Ductwork:
   1. Fabricate and support in accordance with:
      a. SMACNA (RIDC) and SMACNA (ROUND).
   2. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline.
   3. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
   4. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA (ROUND).
   5. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow, with liquid adhesive plus sheet metal screws.
   6. Joints: Minimum 4 inch cemented slip type, brazed or electric welded to comply with AWS D9.1M/D9.1. Prime coat welded joints.
   7. Provide standard 45 degree lateral wye branch fittings unless otherwise indicated.
   8. Use double nuts and lock washers on threaded rod supports.
C. Flexible Connectors: UL listed, fire-retardant polyethylene impregnated fabric, minimum density 20 oz per sq yd, approximately 2 inches wide, crimped into metal edging strip.
D. Blast Gates: Half collar of cast aluminum, with galvanized steel slide.

2.04 EXHAUST SYSTEM ACCESSORIES

A. Tail Pipe Adapters: Rubber formed to tapered cone with spring clip attachment, adapter size 6 inch, for connection to 2-1/2 inch diameter hose.
B. Flexible Exhaust Hose: Heat resistant neoprene coated fabric spring steel wire reinforced, rated for duty to 260 degrees F and 20 inches WG positive or negative.
C. Overhead Suspension System: System to support overhead hose consisting of 5/16 inch diameter nylon cable, 2 inch diameter cadmium plated cast steel swivel pulleys, 6 inch cadmium plated cast steel cleats.
D. Exhaust Hose Reel: Motor operated, reel with direct-mounted, override switch on motor. The reel to consist of 16 gage, cold rolled steel cylinder with internal aluminum flexible pipe, zinc plated steel stand, two steel springs, brake mechanism, hose stop, hose guide and 16 feet of 2-1/2 inch diameter hose.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions.
B. Install fans with resilient mounting and flexible electrical leads. Refer to Section 22 0548 and Section 26 0583.
C. Install flexible connections at fan inlet and discharge. Ensure metal bands of connectors are parallel with minimum 1 inch flex between ductwork and fan while running.

D. Provide pitot tube openings where required for testing of systems, complete with metal cap with spring device or screw to ensure against air leakage.
E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

END OF SECTION

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SECTION 23 3600 - AIR TERMINAL UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single-duct terminal units.
B. Fan-powered units.
C. Air volume control valves.
D. Active Chilled Beams.
E. Terminal Heating Coils

1.02 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 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
D. ASHRAE Std 130 - Laboratory Methods of Testing Air Terminal Units; 2016.
E. ASTM A492 - Standard Specification for Stainless Steel Rope Wire; 1995 (Reapproved 2019).
F. ASTM A603 - Standard Specification for Metallic-Coated Steel Structural Wire Rope; 2019.
G. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2019.
H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2021a.
I. NFPA 70 - National Electrical Code; 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; 2021.
K. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; 2008.
L. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

1.03 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 6000 - Product Requirements for additional provisions.

1.04 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.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.01 SINGLE-DUCT, VARIABLE-VOLUME AND CONSTANT-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.
   6. Substitutions: See Section 01 6000 - Product Requirements.

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 0923. 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.

2.02 FAN-POWERED SERIES UNITS

A. Manufacturers:
   1. Carrier, a part of UTC Building and Industrial Systems, a unit of United Technologies Corp.: www.commercial.carrier.com.
   2. Price Industries, Inc: www.priceindustries.com.
   3. Trane, a brand of Ingersoll Rand: www.trane.com.
   4. Titus: www.titus-hvac.com
   5. Enviro-tec: www.enviro-tec.com
   6. Nailor Industries Inc[<>]: www.nailor.com.
   7. Substitutions: See Section 01 6000 - Product Requirements.

B. General:
   1. Factory-assembled and wired, AHRI 880 (I-P) rated, horizontal fan-powered terminal unit with blower, blower motor, mixing plenum, and primary air damper contained in a single unit housing.
   2. The primary air assemblies shall be pressure independent and shall reset to any air flow between zero and the maximum air volume.
   3. Casing to be reversible so right or left hand inlet/motor configurations can be achieved in the field by simply flipping factory supplied unit upside down. Discharge opening to be centered.

C. Unit Casing:
   1. Minimum 22 gauge, 0.0299 inch galvanized steel.
   2. Primary Air Inlet Collar: Suitable for standard flexible duct sizes.
   3. Unit Discharge: Rectangular, suitable for flanged duct connection.
   4. Casing shall incorporate primary inlet equalization baffle to reduce noise.
   5. Unit shall have four gasketed access panels, top, bottom and each side. Each access panel is to be large enough to remove or service motor/blower assembly. Each access panel is to be equipped with quick-access, tool-free snap latches that can be manually opened. The access panels shall not be blocked with any accessories like electric coils, controls enclosures, sound attenuators etc.
   6. Return air inlet section shall be furnished with the unit. Section shall be constructed of 20 gauge galvanized steel and internally lined with 2" thick dual density fiberglass insulation.
   7. Plenum Inlet: Filter rack with disposable filters.
      a. 1 inch thick disposable fiberglass filters.

D. Primary Air Damper Assembly:
   1. Heavy-gauge, galvanized steel, or extruded aluminum construction with solid shaft rotating in bearings.
   2. Provide indicator on damper shaft or alternative method for indicating damper position over full range of 90 degrees.
   3. Incorporate low leak (2 percent) damper blades for tight airflow shutoff.
   4. Fan(s): Forward curved, centrifugal type.
   5. Fan Motor:
      a. ECM (Electrically commutated Motor):
         1) Brushless DC controlled by an integrated controller/inverter that operates the wound stator and senses rotor position to electrically commutate the stator.
         2) Permanent magnet type motor with near-zero rotor losses designed for synchronous rotation.
         3) Designed to maintain 70 percent efficiency over the entire operating range.

E. Hot Water Heating Coil:
   1. Coil Casing: Minimum 22 gauge, 0.0299 inch galvanized steel, factory-installed on terminal unit with flanged discharge for attachment to downstream ductwork.
   2. Heavy-gauge aluminum fins, mechanically bonded to tubes.
   3. Copper Tubes: 0.016 inch minimum wall thickness with male solder header connections.

4. Coil leak tested to minimum 305 psig.
5. Base performance data on tests run in accordance with AHRI 410.

F. Chilled Water Cooling Coil:
1. Chilled water coils shall be enclosed in a minimum 20-gauge galvanized steel casing, with flanged construction for attachment to return air ductwork. Coil shall be copper tube with aluminum fins.

G. Electrical Requirements:
1. Single-point power connection.
2. Equipment wiring to comply with requirements of NFPA 70.
3. All electrical components shall be enclosed in a single control box with an access panel mounted on the side of the assembly. All controls shall be sealed from primary air flow. Units shall be CSA certified, ETL listed and ARI certified.
4. When required the control components shall be installed within a controls enclosure provided by the terminal manufacturer. An optional 24 VAV transformer shall be provided by the terminal manufacturer. Speed control shall accept as standard a 0 - 20mA signal for remote fan adjustment from a BAS.

H. Controls:
1. DDC (Direct-Digital Controls):
a. 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. Basis of Design: Price Industries, Inc; SP300 Air Flow Sensor: www.priceindustries.com/#sle.
1) Plastic parts are fire-resistant, complying with UL 94.
2) Provides accuracy within 5 percent with a 90 degree sheet metal elbow directly at the inlet of the assembly.
3) Control tubing is protected by grommets at the wall of the air flow sensor's housing.
4) Furnished with twelve total pressure sensing ports and a center averaging chamber that amplifies the sensed air flow signal.
5) Provide velocity pressure sensor with a removable access section for maintenance.
b. Signal accuracy: Plus/minus five percent throughout terminal operating range.

2.03 AIR VOLUME CONTROL VALVES

A. Manufacturers:
1. Accutrol LLC; _____: www.accutrolllc.com/sle#
2. Antec.
3. Phoenix: www.phoenixcontrols.com
4. Critical Room Control (CRC): www.criticalroom.com
5. Substitutions: See Section 01 6000 - Product Requirements.

B. General:
1. Factory-assembled air volume control valves rated in accordance with AHRI 880 (I-P).
2. Clearly label each unit indicating maximum/minimum cfm, tag/mark number, model number, and manufacturer's order number.

C. Construction:
1. Casing: Minimum 20 gauge, 0.0375 inch Type 316L stainless steel suitable for welding in place without distortion, meeting the requirements of NFPA 90A and UL 181.
2. Damper: Minimum 22 gauge, 0.0299 inch Type 316L stainless steel with teflon damper shaft bearings and damper gasket.
3. Air Leakage: Not exceed 2 percent of the nominal catalog rating 3 in-wc inlet static pressure when tested in accordance with ASHRAE Std 130.
4. Controls Enclosure: 22 gauge, 0.0299 inch zinc-coated steel.
5. Air volume control assemblies to consist of steel, cylindrical flow diverter valve or sliding gate valve.

D. Electrical Requirements:
1. Single-point power connection.
2. Equipment wiring to comply with requirements of NFPA 70.

E. Controls:
1. DDC (Direct-Digital Controls):

a. Basis of Design: Price Industries, Inc; Price Intelligent Controller: www.priceindustries.com/#sle.
   1) The unit level controller to include the following:
      (a) 24 VAC power terminal or RJ-12 Power connection.
      (b) T-Stat Port for thermostat connection.
      (c) Service Port for Price Linker diagnostic equipment.
      (d) Damper actuator.
      (e) Fan output connection.
      (f) LED indication for troubleshooting.
      (g) Three binary staged heating outputs.
      (h) Binary cooling output.
      (i) Supply air temperature (SA-T) sensor input.
      (j) Contact closure input.
      (k) Four analog outputs.
      (l) BACnet expansion module.
b. Include a factory-installed, unit-mounted, direct-digital controller.
c. Bi-directional Damper Actuator: 24 volt, powered closed, spring return open.
d. Microprocessor-Based Controller: Air volume controller, pressure-independent with electronic airflow transducers, factory-calibrated maximum and minimum CFM's.
   1) Occupied and unoccupied operating mode.
   2) Remote reset of temperature or CFM set points.
   3) Proportional, plus integral control of room temperature.
   4) Monitoring and adjusting with portable terminal.
   5) Time-proportional reheat coil control.
e. Room Sensor:
   1) Compatible with temperature controls specified.
   2) Wall-mounted, system powered, with temperature set-point adjustment including connection access for portable operator terminal.

2. Airflow Sensor: Differential pressure airflow device measuring total, static, and wake pressures.
   a. Basis of Design: Price Industries, Inc; SP300 Air Flow Sensor: www.priceindustries.com/#sle.
      1) Plastic parts are fire-resistant, complying with UL 94.
      2) Provides accuracy within 5 percent with a 90 degree sheet metal elbow directly at the inlet of the assembly.
      3) Control tubing is protected by grommets at the wall of the air flow sensor's housing.
      4) Furnished with twelve total pressure sensing ports and a center averaging chamber that amplifies the sensed air flow signal.
      5) Provide velocity pressure sensor with a removable access section for maintenance.
   b. Signal accuracy: Plus/minus five percent throughout terminal operating range.

2.04 ACTIVE CHILLED BEAMS:

A. All units shall consist of a casing manufactured from 20 GA G-60 galvanized steel conforming to ASTM-653 standards. Casing shall house a water coil and primary air plenum delivering air to a series of induction nozzles. A single oval (or round) air connection spigot shall be mounted on the side or end (not top) of the unit as indicated on the drawings. All sheet metal joints in the primary air plenum and air connection spigot shall be sealed airtight.

B. The active chilled beam visible face shall comprise two linear supply air slots positioned either side of a 50% free area perforated room air induction section. Induction grille shall be released for access to the coil without the use of tools. The supply air discharge slots shall be formed from aluminum extrusions. The aesthetic appearance of both one and two discharge chilled beams shall be identical. Induction air grille shall be manufactured from perforated aluminum alloy conforming to ASTM-B209. Nozzle plate shall be painted black. The entire visible face section including the supply air slots, end plates and induction grille assembly shall be painted white. Active chilled beams shall be designed for flush integration into a standard 24" wide module T-bar lay-in ceiling.

C. Primary air shall be discharged into the mixing chamber through multi-lobed induction nozzles. The size and quantity of nozzles shall be selected to provide the primary and secondary airflows at the inlet static pressure and noise levels specified.
D. Active chilled beams shall be fitted with a commissioning tube for measuring the static pressure differential between the primary air plenum and the room. The commissioning tube shall be accessible from the induction air grille and be sealed airtight with a removable plug or cap. Each active chilled beam shall be provided with an airflow calibration chart showing primary airflow rate for given nozzle configuration at different static pressures
E. Secondary water coils shall be two or four pipe configuration as indicated on the schedules. Coils shall be mounted horizontally and manufactured with ½" seamless copper tubing with a minimum 0.016" wall thickness mechanically expanded into corrugated aluminum fins spaced at 12 FPI (fins per inch). Coils shall be mounted in a galvanized steel frame shielding the fin corners and sides to minimize risk of injury during cleaning. Water velocity in the tubes shall be at least 50 FPM and not exceed 240 FPM. The coils shall have a maximum working pressure of no less than 300 PSI and be factory tested for leakage at 500 PSI. Coils shall be rated in accordance with AHRI standard 410. Coil connections shall be ½" O.D. bare copper for field sweating to the water circuit. Water coils connection handing shall be as shown on the Drawings.
F. Provide 1/8" thick thermal insulation applied to the interior of the primary air plenum to prevent condensation forming on the outside of the unit casing and the interior surfaces of the primary air chamber.
G. Provide a lint screen shall be installed within the unit casing between the air induction grille and coil and shall be removable without tools.
H. Units mounted in lay-in tile ceilings with 2-way air throws shall be provided with vertical or angled chilled water coils and drip pans housed inside the unit above the beam face to catch any condensation that may occur. As the chilled beam manufacturer's option, a horizontal slab coil may be provided with a condensation sensor that will close the chilled water control valve when a condensation condition may occur.
I. Units being mounted in a bulkhead or SheetRock shall be provided with a trim kit. Trim kits to be polyester powder coated white. Concealed bulkhead active chilled beams shall be provided with separate supply and return air grilles.
J. Active chilled beams shall be independently suspended from the structure at four points for units up to and including six feet in length. Units longer than six feet shall be suspended from the structure with six support points. Units to be suspended with a minimum of 3/8" diameter threaded rod.
K. Acceptable manufacturers shall be Dadanco, Titus, Trox, Price, Semco, Swegon or approved equal.

2.05 TERMINAL HEATING COILS:

A. Terminal heating coils shall be suitable for hot water and have same end connections.
B. Terminal heating coils shall be furnished according to the schedule on the drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are suitable for installation.
B. Verify that field measurements are as indicated on drawings.

3.02 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 3100.

3.03 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.

3.04 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements for additional requirements.

3.05 CLEANING

A. Vacuum clean coils and inside of units.

B. Install new filters.

3.06 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals for closeout submittals.

B. See Section 01 7900 - Demonstration and Training for additional requirements.

END OF SECTION

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SECTION 23 3700 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Diffusers:
B. Rectangular ceiling diffusers.
C. Slot ceiling diffusers.
D. Registers/grilles:
    1. Ceiling-mounted, egg crate exhaust and return register/grilles.
    2. Ceiling-mounted, exhaust and return register/grilles.
    3. Ceiling-mounted, linear exhaust and return register/grilles.
    4. Ceiling-mounted, supply register/grilles.
    5. Wall-mounted, supply register/grilles.
    6. Wall-mounted, exhaust and return register/grilles.
    7. Wall-mounted, grid core exhaust and return register/grilles.
    8. Wall-mounted, linear register/grilles.
E. Roof hoods.

1.02 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.
C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

1.03 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.

1.04 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

2.01 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
F. Substitutions: See Section 01 6000 - Product Requirements.

2.02 RECTANGULAR CEILING DIFFUSERS

A. Type: Provide square plaque diffuser to discharge air in 360 degree pattern.
B. Connections: Round.
C. Frame: Provide inverted T-bar type. In plaster ceilings, provide plaster frame and ceiling frame.
D. Fabrication: Steel with baked enamel finish.
E. Color: Standard White.

2.03 CEILING SLOT DIFFUSERS

A. Type: Continuous 1 inch wide slot, four slots wide, with adjustable vanes for left, right, or vertical discharge.
B. Fabrication: Aluminum extrusions with factory clear lacquer finish.
C. Color: To be selected by Architect.
D. Frame: 1-1/4 inch margin with concealed mounting and gasket, mitered end border.
E. Plenum: Integral, galvanized steel, un-insulated.

2.04 CEILING SUPPLY REGISTERS/GRILLES

A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, one-way deflection.
B. Frame: 1-1/4 inch margin with concealed mounting and gasket.
C. Construction: Made of aluminum extrusions with factory enamel finish.
D. Color: As selected by Architect from manufacturer's standard range.
E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.05 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, vertical face.
B. Frame: 1-1/4 inch margin with concealed mounting.
C. Fabrication: Steel with 20 gauge, 0.0359 inch minimum frames and 22 gauge, 0.0299 inch minimum blades, steel and aluminum with 20 gauge, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.
D. Color: To be selected by Architect from manufacturer's standard range.
E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.

2.06 CEILING EGG CRATE EXHAUST AND RETURN GRILLES

A. Type: Egg crate style face consisting of 1/2 by 1/2 by 1/2 inch grid core.
B. Fabrication: Grid core consists of aluminum with mill aluminum finish.
C. Frame: Channel lay-in frame for suspended grid ceilings.
D. Accessories: Provide integral gang and face operated opposed blade damper, 2 inch filter frame, plaster frame, square mesh insect screen, square mesh debris screen, prescored molded fiberglass back, and 45 degree angled eggcrate or other similar provisions for visual blocking such as angled louver or 90 degree duct elbow.

2.07 WALL SUPPLY REGISTERS/GRILLES

A. Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical face, double deflection.
B. Frame: 1-1/4 inch margin with concealed mounting and gasket.
C. Fabrication: Steel with 20 gauge, 0.0359 inch minimum frames and 22 gauge, 0.0299 inch minimum blades, steel and aluminum with 20 gauge, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.
D. Color: To be selected by Architect from manufacturer's standard range.
E. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

2.08 WALL SUPPLY REGISTERS/GRILLES

A. Type: Streamlined and individually adjustable curved blades to discharge air along face of grille with one-way deflection.
B. Fabrication: Aluminum extrusions with factory clear lacquer finish.
C. Color: To be selected by Architect from manufacturer's standard range.
D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.09 WALL EXHAUST AND RETURN REGISTERS/GRILLES

A. Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, vertical face.
B. Frame: 1-1/4 inch margin with concealed mounting.
C. Fabrication: Steel frames and blades, with factory baked enamel finish.
D. Color: To be selected by Architect from manufacturer's standard range.
E. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.10 ROOF HOODS

A. Fabricate air inlet or exhaust hoods in accordance with SMACNA (DCS).
B. Hoods shall be weatherproof, low contour type, constructed with all aluminum housings, be furnished with bird guard, aluminum insect screen, and square or rectangular curb cap, and shall have hinging arrangement to allow access to dampers or control equipment.
C. Intake hoods shall be provided with optional 12" tall base.

D. Relief/exhaust hoods shall be provided with optional 12" tall base.
E. All intake hoods shall be furnished with a 6" skirt/shroud that extends from the edge of the hood down. Skirt shall be attached to the bottom edge of the hood overhang. Skirt shall be the same material as the hood.
F. All relief/exhaust hoods shall be furnished with a 6" skirt/shroud that extends from the edge of the hood down. Skirt shall be attached to the bottom edge of the hood overhang. Skirt shall be the same material as the hood.
G. Curbs for air intakes shall be furnished in sizes suitable for the curb cap of the vent or intake served. Curbs for fresh air intakes shall be sized so that the bottom of the hood shroud is a minimum of 36" height above the finished roof surface. Provide additional blocking or curb extension to achieve this height.
H. Curbs for relief vents and gravity vents shall be furnished in sizes suitable for the curb cap of the vent or intake served. Curbs for relief vents and gravity vents shall be a minimum of 30" height. Provide additional blocking or curb to achieve this height. Curbs for relief vents shall be insulated with minimum R-12 insulation.
I. Fabricate louver penthouses with mitered corners and reinforce with structural angles.
J. All relief/exhaust hoods shall be furnished with a backdraft damper.
K. Roof hoods shall be furnished with a motorized damper.
L. Acceptable manufacturers shall be Greenheck, Cook, Twin City Fan or approved equal.

PART 3 EXECUTION

3.01 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 Section 09 9123.

END OF SECTION

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SECTION 23 5700 - HEAT EXCHANGERS FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Shell and tube type heat exchangers.

B. Accessories and trim.

1.02 RELATED REQUIREMENTS

A. Section 23 2114 - Hydronic Specialties.

B. Section 23 2214 - Steam and Condensate Heating Specialties.

1.03 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Shop Drawings:
   1. Product Data: Provide data with dimensions, locations, and size of tappings and performance data.
   2. Indicate dimensions, locations, and size of tappings and performance data.
      a. Design Data: Indicate in sufficient detail to verify that heat exchangers meet or exceed specified requirements.

C. Closeout Documents:
   1. Manufacturer's Instructions: Indicate installation and support requirements.
   2. Operation and Maintenance Data: Include start up and shut down instructions, assembly drawings, and spare parts lists.
   3. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 REGULATORY REQUIREMENTS

A. Conform to ASME BPVC-VIII-1 for manufacture of tubular heat exchangers and heat exchanger shells.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect internals from entry of foreign material by temporary caps on flanged openings.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for _____.

PART 2 PRODUCTS

2.01 SHELL AND TUBE TYPE HEAT EXCHANGER

A. Manufacturers:
   1. Armstrong Pumps Inc; _____: www.armstrongpumps.com/#sle.
   2. Bell & Gossett, a xylem brand; _____: www.bellgossett.com/#sle.
   3. Taco
   4. Patterson Kelly
   5. Substitutions: See Section 01 6000 - Product Requirements.

B. Tubes: U-tube type with 3/4 inch OD minimum seamless copper tubes suitable for 125 psi working pressure.

C. Shell: Steel pipe with threaded or flanged piping connections and necessary tappings, steel saddle and attaching U-bolts, prime coated.

D. Heads: Cast iron or fabricated steel with steel or bronze tube sheets, threaded or flanged for piping connections.

E. Heat exchangers shall be furnished complete with steel saddles and shall be mounted on pipe stands rigidly braced, or on heavy angle wall brackets.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install to permit removal of tube bundle with minimum disturbance to installed equipment and piping.

C. Support heat exchangers on concrete housekeeping pad.

D. Pitch shell to completely drain condensate.

E. Pipe relief valves to nearest floor drain.
F. Pipe drain valves to nearest floor drain.

3.02 STEAM TO WATER HEAT EXCHANGER TRIM

A. Shell: Pressure gauge tapping with pigtail siphon, vacuum breaker; see Section 23 2214.
B. Contractor shall provide and install 1/2" swing check vacuum breakers on the shell of all steam to hot water heat exchangers.
C. Water Inlet: Thermometer well, pressure gauge tapping, valved drain; see Section 23 2114.
D. Water Outlet: Thermometer well for temperature regulator sensor, ASME rated pressure and temperature relief valve, thermometer well, pressure gauge tapping; see Section 23 2114.

END OF SECTION

SECTION 23 6426 - ROTARY-SCREW WATER CHILLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air-cooled rotary-screw chiller.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete housekeeping pads.
B. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.
C. Section 23 0800 - Commissioning of HVAC.
D. Section 23 0993 - Sequence of Operations for HVAC Controls.
E. Section 23 2113 - Hydronic Piping.
F. Section 23 2114 - Hydronic Specialties.
G. Section 25 1500 - Integrated Automation Software.
H. Section 26 0583 - Wiring Connections.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate physical size, weight and location of major pieces of equipment to be installed. Notify Engineer of any major deviations from the equipment originally specified prior to ordering equipment.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.
C. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.
D. Manufacturer's Certificate: Certify that components furnished but not produced by manufacturer meet or exceed manufacturer's requirements.
E. Manufacturer's Performance Data: Indicate energy input versus cooling load output from 0 to 100 percent of full load at specified and minimum condenser water temperature for water-cooled chillers and at specified and minimum outdoor air temperature for air-cooled chillers.
F. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.
G. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories; include trouble-shooting guide.
H. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written installation instructions for rigging, unloading, and transporting units.
B. Deliver units to the job site completely assembled and charged with refrigerant and oil by manufacturer.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
B. Manufacturer's Warranty: Provide minimum five year warranty to include coverage for materials only for compressor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Daikin Applied: www.daikinapplied.com/#sle.
B. Trane, a brand of Ingersoll Rand: www.trane.com/#sle.
C. York International Corporation/Johnson Controls, Inc: www.york.com/#sle.
D. Substitutions: See Section 01 6000 - Product Requirements.
    1. The chilled water system has been designed based on specific capacities and characteristics of equipment specified in this section and other sections.

2.02 AIR COOLED SCREW TYPE CHILLER:

A. Furnish and install as shown on plans, an air cooled screw compressor water chiller(s) having the capacity as scheduled on the drawings. Ratings shall be in accordance with the latest edition of AHRI Standard 550/590 provided the application ratings are within the scope of the standard. Construction shall be in accordance with

ANSI/ASHRAE 15, ASHRAE 90.1 current version requirements and ASME Section VIII. Safety Code and National Electrical Code* (NEC). Chiller shall have safety agency approval by Electrical Testing Laboratories (ETL) or Canadian Electrical Testing Laboratories (CETL).

B. The single-piece air cooled chiller shall be completely factory assembled and fully run tested with water hookups prior to shipment. The chiller shall consist of screw compressors, motors, evaporator, condenser, refrigerant and oil operating charges, microprocessor control system and documentation required prior to start-up. The warranty period shall commence at the date of initial start-up and shall continue for a period of one (1) year, compressors and refrigerant system shall be warranted for five (5) years.

C. Unit casing and all structural members and rails shall be fabricated of continuous G90 galvanized steel and galvanized steel channel. The galvanized coating shall be applied to the base metal by the hot dip process. All structural members and rails shall be 10-gauge thickness, control boxes 15-gauge thickness and unit panels 17-gauge thickness. Exterior casing shall be phosphatized and painted with a urethane finish. (Architectural louvered panels shall cover the condensing coils and access area below coils.) (Coated wire mesh shall cover the access area below coils and expanded metal hail guards cover condensing coils.)

D. The main screw rotor shall be constructed of a high alloy steel. The semi-hermetic compressor shall utilize an internal economizer cycle to enhance the unit's refrigeration effect and to allow the compressor to run at a more efficient operating point. A liquid refrigerant injection system shall be utilized to seal potential leakage paths between high and low sides of the compressor. Slide valve modulation shall be provided for unloading control. The compressor shall be field serviceable, direct drive, 3600 rpm.

E. The electric motor shall be hermetically sealed, squirrel cage induction type and cooled by liquid refrigerant. Compressor power factor shall be 0.90 or greater.

F. Evaporator shall be of the direct expansion type with carbon steel barrel, polypropylene water baffles and seamless, internally finned high efficiency copper tubes. Tubes shall be roll expanded into heavy carbon steel tube sheets. Refrigerant heads shall be carbon steel and removable to permit access to tubes from either end. For easy removal of water, vent and drain plugs shall be provided on the shell. The evaporator shall be wrapped with an electric heater cable and insulated with 3/4" thick closed cell polyurethane insulation [K=0.28 at 75°F] to provide freeze protection down to -20°F ambient air temperature. The insulation shall be fitted and cemented in place, then painted with a resilient vinyl paint to resist cracking. The evaporator shall be designed for refrigerant side working pressure of 225 psig and water side working pressure of 175 psig. The evaporator shall be designed, constructed, inspected and stamped in accordance with ASME Code requirements.

G. Condenser coils shall be constructed of 3/8" O.D. seamless copper tubes and mechanically expanded into plate type aluminum fins. The fins shall have full drawn collars to completely cover the copper tube. A sub-cooling coil shall be an integral part of the main condenser coil.

H. Condenser fans shall be propeller type arranged for vertical air discharge and individually driven by direct drive fan motors. Fan blades shall be a painted steel or unpainted aluminum. Each fan shall be protected by a heavy-gauge fan guard. Condenser fan motors shall be three-phase, direct drive, open drip-proof type positioned within the unit cabinet for weather protection.

I. 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 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.

J. Terminals shall be provided for field connection of a 115-volt power supply to the control circuit and evaporator freeze protection heater circuit. A flow switch shall be provided for field installation.

K. Control panel shall include factory mounted solid state, reduced voltage starters.

L. A microprocessor-based control system shall be utilized for precise monitoring and control of the air-cooled chiller based on the leaving evaporator water temperature. The microprocessor control system shall include electronic expansion valves and utilize advance fuzzy logic control to provide at least 5 steps of fan control for each circuit to maintain optimum condenser pressure control for maximum operating unit efficiencies. Traditional ambient temperature thermostats and pressure switches are not acceptable. The microprocessor shall continuously calculate the optimum condenser pressure for each circuit based upon

compressor capacity, outside air temperature and number of condenser fans in operation. The controller shall feature an easy-to-use keypad and digital display that provides access to temperatures, pressures, set points, operating states, schedules and alarm messages in plain English. Coded messages are not acceptable. The controller shall be able to log chiller operating conditions so that the operator can view them from a single keypad/display instead of reading external gauges, thermometers, potentiometers, etc. The controller shall include password protection to guard against unauthorized or accidental setpoint or parameter changes.

M. The air-cooled chiller shall have refrigerant circuits completely independent of each other with one compressor per circuit being utilized. Multiple compressors on a single circuit are not acceptable. Each circuit shall include an electronic expansion valve, compressor suction and discharge service valves, manual liquid line shutoff valve with charging connection, replaceable core filter-drier, liquid line sight glass with moisture indicator, liquid line solenoid valve, purge valves, 450 psig relief valves and insulated suction line. A liquid line solenoid valve is required to prevent liquid refrigerant from entering the compressor in case of a power failure where the electronic expansion valve would not be able to close. Each circuit shall include two pressure transducers, one for the evaporator and one for the condenser. The output shall feed directly to the microprocessor control system.

N. All roof mounted units shall be furnished with spring type vibration isolators.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Align chiller package on steel or concrete foundations.

C. Install units on vibration isolators.

D. Connect to electrical service.

E. Connect to chilled water piping.

F. Arrange piping for easy dismantling to permit tube cleaning and removal.

G. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 25 1500.

3.02 MANUFACTURER'S FIELD SERVICES

A. Perform factory startup of the chiller by factory trained and authorized servicing technicians confirming equipment has been correctly installed prior to equipment becoming operational and covered under the manufacturer's warranty.

B. Supply initial charge of refrigerant and oil if not completely factory charged.

C. Demonstrate system operations and verify specified performance.

3.03 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals for closeout submittals.

B. See Section 01 7900 - Demonstration and Training for additional requirements.

C. Demonstrate proper operation of equipment to Owner's designated representative.

D. 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.

E. 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.

3.04 MAINTENANCE

A. See Section 01 7000 - Execution and Closeout Requirements for additional requirements.

END OF SECTION

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SECTION 23 6533 - LIQUID COOLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Liquid cooler.

B. Controls.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

A. ASME PTC 23 - Atmospheric Water Cooling Equipment; 2003 (Reaffirmed 2023).

1.04 SUBMITTALS

A. Product Data: Provide rated capacities, dimensions, weights and point loadings, accessories, required clearances, electrical requirements and wiring diagrams, and location and size of field connections. Submit schematic indicating capacity controls.

B. Shop Drawings: Indicate suggested structural steel supports including dimensions, sizes, and locations for mounting bolt holes.

C. Certificates: Certify that liquid cooler performance, based on ASME PTC 23 meet or exceed specified requirements and submit performance curve plotting leaving water temperature against wet bulb temperature.

D. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.

E. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories. Include cleaning methods and cleaning materials recommended.

F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Factory assemble entire unit. For shipping, disassemble into as large as practical sub-assemblies so that minimum amount of field work is required for re-assembly.

B. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide a five year warranty to include coverage for liquid cooler package, labor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Baltimore Aircoil Company, Inc: www.baltimoreaircoil.com.

B. EVAPCO, Inc: www.evapco.com.

C. Direct Coil.

D. Krack.

E. Chandler.

F. Liebert.

G. Data-Aire.

H. Substitutions: See Section 01 6000 - Product Requirements.

2.02 FLUID COOLER:

A. A. The fluid cooler shall be designed to reject waste heat to outdoor air and to control glycol temperature at pumped glycol rates as outdoor ambient conditions change. The fluid cooler shall be a factory-assembled unit, complete with integral electrical panel, designed for outdoor installation and vertical airflow.

B. The fluid cooler shall consist of dry cooler coils, housing, propeller fans direct-driven by individual fan motors, electrical controls and mounting legs.

C. The coil shall be constructed of copper tubes in a staggered tube pattern. Tubes shall be expanded into continuous, corrugated aluminum fins. The fins shall have full-depth fin collars completely covering the copper tubes, which are connected to heavy wall Type "L" headers. Inlet coil connector tubes pass through relieved holes in the tube sheet for maximum resistance to piping strain and vibration. Coil shall be split flow into multiple coil circuits. Coils shall be factory leak-tested at a minimum of 300 psig, dehydrated, then filled and sealed with an inert gas holding charge for shipment.
D. The fluid cooler housing shall be constructed of galvanized steel and divided into individual fan sections by full-width baffles. Structural support members, including coil support frame, motor and drive support, shall be galvanized steel for strength and corrosion resistance. Legs shall be provided to mount unit for vertical air discharge and shall have rigging holes for hoisting the unit into position. An electrical panel shall be inside an integral NEMA 3R weatherproof section of the housing.
E. The propeller fan shall have blades secured to a corrosion protected steel hub. Fans shall be secured to the fan motor shaft by means of a keyed hub and dual setscrews. Fans shall be factory-balanced and run before shipment.
F. The fluid cooler shall be installed in accordance with the manufacturer's installation instructions. Install unit plumb and level, firmly anchored in location indicated, and maintain manufacturer's recommended clearances.
G. Install and connect electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish a copy of the manufacturer's electrical connection diagram submittal to the electrical contractor. Install and wire per local and national codes.
H. Install and connect devices furnished by manufacturer but not specified to be factory-mounted. Furnish a copy of manufacturer's piping connection diagram submittal to the piping contractor.
I. Start fluid cooler in accordance with manufacturer's startup instructions. Test controls and demonstrate compliance with requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that openings are ready to receive work.
B. Verify field measurements are as indicated on drawings.
C. Verify that required utilities are available, in proper location, and ready to use.
D. Beginning of installation means installer accepts existing conditions.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Provide the services of the manufacturer's field representative to supervise rigging, hoisting, and installation, allowing for minimum of one eight hour day per tower.
C. Install cooler on vibration isolators. Refer to Section 23 0548.
D. Connect cooler water piping with flanged connections to cooler. Refer to Section 23 2113.
E. Connect make-up water piping with flanged or union connections to cooler. Pitch to cooler. Pipe drain, overflow drain, and bleed lint to nearest floor drain. Refer to Section 22 1005.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Provide the services of the manufacturer's field representative to inspect tower after installation and submit report prior to start-up, verifying installation is in accordance with specifications and manufacturer's recommendations.

3.04 SYSTEM STARTUP

A. Prepare and start systems.
B. Provide operation test to demonstrate operation in accordance with specified requirements. Refer to Section 23 0593.

3.05 ADJUSTING

A. Adjust level sensor and contoler for proper operating level.
B. Adjust bleed valve for proportion of circulated water.
C. Adjust temperature controls and verify operation.

END OF SECTION

SECTION 23 7313 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Casing construction.
B. Fan section.
C. Coil section.
D. Air-to-air energy recovery flat plate heat exchanger.
E. Filter and air cleaner section.
F. Damper section.
G. Rotary air-to-air energy recovery wheel section.
H. Air-to-air desiccant dehumidification wheel.
I. Air blender section.

1.02 RELATED REQUIREMENTS

A. Section 23 0513 - Common Motor Requirements for HVAC Equipment.
B. Section 23 3416 - Centrifugal HVAC Fans.
C. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.
B. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).
C. AHRI 1060 (I-P) - Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment; 2023.
D. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
E. AMCA 99 - Standards Handbook; 2016.
F. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2016, with Errata (2018).
G. AMCA 300 - Reverberant Room Method for Sound Testing of Fans; 2014.
H. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.
I. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2018.
J. 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.
K. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
L. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.
M. UL 1812 - Ducted Heat Recovery Ventilators; Current Edition, Including All Revisions.
N. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.04 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.

1.05 SUBMITTALS

A. See Section 01 3000 - 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 6000 - Product Requirements for additional provisions.
    b. Extra Fan Belts: One set for each unit.
    c. Extra Filters: Two sets for each unit.

1.06 QUALITY ASSURANCE

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

1.07 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by {\rs\#1} as suitable for the purpose specified and indicated.

1.08 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.

1.09 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Carrier Corporation: www.carrier.com.
B. Daikin Applied: www.daikinapplied.com.
C. Trane Inc: www.trane.com.
D. York International Corporation / Johnson Controls Inc: www.york.com.
E. Nortek.
F. Scott Springfield.
G. Substitutions: See Section 01 6000 - Product Requirements.
H. 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 Trane, Carrier and York 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.

2.02 CASING CONSTRUCTION

A. Full Perimeter Base Rail:
    1. Construct of galvanized steel or aluminum tube.
    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 3-inch thick, thermal broke double wall assembly, injected with foam insulation for an R-value of not less than R-13.

2. Floors: Floor surface will be 1/8" thick aluminum diamond checkered plate, continuous welded construction.
    a. Insulation: 3-inch thick closed cell foam R24 insulation within the structural floor cavity and protected from underneath by a 24 gauge galvanized steel liner.
    b. Provide a thermal break separating interior and exterior surfaces.
    c. Drain Connections: Extended through the unit base frame, for floor drains in sections downstream of cooling coils and humidifiers, and as indicated on the Drawings.
3. Provide mid-span, no through metal, internal thermal break.
4. Walls and Ceilings Panels: 3-inch thick R24 insulated double-wall panels.
    a. Provide a thermal break separating interior and exterior surfaces, which will prevent condensation on any portion of standard units
    b. Exterior Panel Materials: Minimum 0.063 Embossed Alum on indoor units and painted 16-gauge G90 galvanized steel on Outdoor units
    c. Internal Panel Materials:
        1) 20-gauge, minimum, 304 stainless steel solid panels at, and 3 feet downstream of wet sections such as cooling coils.
        2) 20-gauge, minimum, G90 galvanized steel solid panels in dry sections
    d. Unit construction will provide a maximum leakage rate of not more than 1.0 percent at the specified design conditions.
    e. Provide framed and gasketed openings for ductwork, piping, and electrical conduit penetrations of cabinet walls. Closures around piping and conduit will be completed according to details provided by the unit manufacturer.
    f. Provide a conduit through a common corner of each section of the air handling unit.
        1) For use by controls contractor to avoid excessive penetrations of unit construction.
        2) External penetrations of conduit to be factory sealed to prevent air bypass.
        3) Internal conduit opening to be sealed by controls contractor after use.
5. Insulation - Injected Foam:
    a. Thickness: Insulating foam shall fill the entire double wall cavity, which can be reduced as low as nominal 3" thick, as long as greater than R24.
6. 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.
7. 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.
8. 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. Double-wall, solid insulated access doors with heavy duty hinges, latches, handles; gaskets, and test ports if indicated on drawings. Same Construction Properties as unit walls and ceiling.
2. Provide full-sized 24" W x 70" T access doors on fan sections, coil access sections, filter sections, and as indicated on the Drawings.
3. Unless noted otherwise, access doors shall open in a direction against pressure to avoid unpredictable opening forces (ie, positive pressure sections shall have inwardly opening doors, and negative pressure

sections shall have outwardly opening doors).

4. All section doors shall have inspection windows, 8-inch x 8-inch minimum. Thermal conductance of the windows shall not exceed 0.65 BTU /hr /sq. ft.

D. 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.

E. Drain Pan Construction:
   1. Provide cooling coil sections with an insulated, double wall, stainless steel drain pan complying with ASHRAE Std 62.1 for indoor air quality and sufficiently sized to collect all condensate.
   2. Slope in two planes to promote positive drainage and eliminate stagnate water conditions.
   3. Locate outlet of sufficient diameter at lowest point of pan to prevent overflow at normal operating conditions.
   4. Provide threaded drain connections constructed of drain pan material, extended sufficient distance beyond the base to accommodate field installed, condensate drain trapping. Drain connection centerline shall be above the base rail.
   5. Provide drain pans under all cooling coil, humidifier and heat recovery sections.
   6. Provide full 2" thickness of insulation under drain pan. Drain pans shall have a minimum height of 2" at the side.

F. Marine Lights:
   1. Provide factory-mounted, water- and dust-resistant LED fixture(s) where indicated on drawings, with the following characteristics:
      a. Non-ferrous metal housing.
      b. Glass or polycarbonate lens.
      c. Factory wired to a single switch within factory provided service module.
      d. Instant on white light with minimum 8,000 hour service life.
   2. Provide factory installed service module including GFCI receptacle independent from load side; designed to receive power from field supplied 120 volt source.

2.03 FAN SECTION

A. Performance Ratings: Determined in accordance with AMCA 210 and labeled with AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301; tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.

C. Fan assemblies including fan, motor and sheaves shall be dynamically balanced by the manufacturer on all three planes and at all bearing supports.

D. 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.

E. 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.

F. 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.

G. External Motor Junction Box: Factory mount NEMA 4 external junction box and connect to extended motor leads from internally mounted motors.

H. Fan Accessories:

I. Units With Fan Arrays:
   1. Description: Multiple, direct-drive, arrangement 4 plenum fans, for supply and return/exhaust air sections.
   2. Fan Array Performance:
      a. Fan array shall include multiple direct drive, Arrangement 4 plenum fans constructed per AMCA requirements for the duty specified.

1) Fan Performance: Minimum Class II; Class III may be required based on operating parameters.

b. The fan array shall be selected to operate at a system total static pressure (TSP) that does not exceed 90% of the specified fan's peak static pressure producing capacity at the specified fan/motor speed.

c. The fan array shall produce a uniform airflow and velocity profile within the airway tunnel of the air handling unit within 10% of the filter/coil face velocity specified when measured 12" upstream and 48" downstream of the array.

3. Fan Array Assembly:
   a. Description: Factory-fabricated, -assembled, -tested, and -finished, direct-drive plenum fans consisting of wheel, fan shaft, bearings, motor, fan shroud and support structure.
   b. Airfoil Wheels: Single-width-single-inlet construction with smooth-curved inlet cone; hollow die-formed, airfoil-shaped steel blades continuously welded at tip flange and backplate; and cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
   c. Fan Shroud: 16-gauge steel shroud lined with sound absorbing media; media shall be encapsulated with a UL approved membrane.
   d. Each fan/motor cube or cell shall include a 12 gauge, G90U galvanized steel intake wall,14 gauge spun steel fan inlet funnel, and a 10 gauge G90 Galvanized steel motor support plate rail and structure, or equivalent, for system rigidity and vibration needs.
   e. Each fan inlet cone shall be provided with piezo taps for fan airflow measurement. All taps shall be connected in parallel and brought to a single barb connection fitting.
   f. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower.
      1) Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
   g. Ceramic permanent lubricated motor bearings:
      1) Bearing Rating Life: ABMA L10 of 150,000 hours, minimum.
   h. Each fan/motor assembly shall be dynamically balanced according to AMCA standard 204-96, to exceed category BV-5 and exceed Grade G.55, producing a maximum rotational imbalance of 0.022" per second peak, filter in.
   i. Fan and motor assemblies with 27" diameter fans and less shall be balanced to meet or exceed the G.55 residual imbalance.
      1) Fan and motor assemblies incorporating larger than 10 HP motors shall be balanced in not less than three orthogonal planes to demonstrate compliance with an imbalance criteria not to exceed 0.022" per second.
   j. Motors: Shall be specifically manufactured for use in multiple fan array applications. NEMA Premium efficient, inverter-duty.
   k. Provide easily removable, OSHA approved fan and motor protective guards.
4. Acoustical Performance:
   a. A discharge coplanar silencer shall be required so that discharge radial fan noise shall pass through acoustically attenuated wall panels within the fan array.
   b. The multiple fan array unit manufacturer shall provide the acoustical performance for the unit supply, return, outside air, and relief air openings, as well as for casing radiated noise levels.
   c. See schedules for project specific allowable AHU sound benchmarks.
5. Array Construction:
   a. Each fan and motor assembly shall be removable through a standard air handling unit access door located on the discharge side of the fan array.
6. Fan Backdraft Prevention:
   a. Each individual cube or cell in the multiple fan array shall be provided with an integral, automatic, non-motorized backflow prevention device to prohibit recirculation of air in the event one or more fans are disabled.

b. Backflow prevention devices shall have near zero static pressure drop and negligible system effect losses attributed to them when the fan is enabled and the damper open.

J. Electrical Systems:
1. Power Distribution Panels:
a. For each set of fans, provide a power distribution panel which shall include a power distribution block and motor overload protection, short circuit protection, and manual disconnecting means for each fan.
2. Electrical wiring from the power distribution panel out to the fans shall be the responsibility of the manufacturer.
3. Electrical wiring from factory installed VSDs to the power distribution panels shall be the responsibility of the manufacturer.
4. Electrical wiring from the building service to the unit and to the VSDs shall be the responsibility of Division 26.
5. Provide 120V GFI receptacles and lights prewired in the factory. Provide a separate power connection, with non-fused disconnect, for these circuit(s).

K. Variable Speed Drives:
1. Comply with AMCA 99. VSDs shall be provided by the air handling unit manufacturer, and shall be the same VSD manufacturer and model family as the other predominant VSDs being utilized on the Project.
2. Bearings: Heavy duty pillow block type, ball bearings, with ABMA STD 9 L-10 life at 50,000 hours.
3. Shafts: Solid, hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

2.04 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. Provide a coil access door between coils for coil cleaning and service. Provide a minimum 30 inches clear space between coils.

C. Intermediate Coil Supports: Provide intermediate coil supports at no greater than 4 feet spacing.

D. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high. Provide vent and drain connections on all fluid coils. Coil shall be designed for 100% drainage at low point.

E. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410.

F. Source Quality Control: Test to 300 psig and to 200 psig underwater.

G. Eliminators: Three break of Type 304 stainless steel, mounted over drain pan.

H. 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.

I. 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.

J. Water Heating Coils:
1. Headers: Seamless copper tube with brazed joints; prime coated with drain and air vent tappings.
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.
4. Minimum 0.0635 inch galvanized-steel channel frame for heating coils.

K. Water Cooling 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; threaded plugs in return bends and in headers opposite each tube.
3. Cooling coils shall have a maximum of 9 fins per inch.

4. Stainless steel construction for cooling coils.
5. Maximum number of rows: 8 rows (cooling).

2.05 AIR-TO-AIR ENERGY RECOVERY FLAT PLATE HEAT EXCHANGER

A. The exchanger plates shall be 99.9% pure aluminum. Plates made from aluminum alloys, plastic, fiber, steel or other material(s) are unacceptable.
B. The plates shall be die formed with the patented positive/negative dimple stamping. Plate profiles of the laminar flow design type are unacceptable.
C. Aluminum plate thickness shall be 0.005" (0.127 mm) for the best possible effectiveness. Thicker aluminum plates shall not be acceptable.
D. The connecting plate edges shall be multiple folded. The double fold shall provide a six fold material thickness on the leading and trailing edges of the plate exchanger and provide protection from the cutting edge of teh exchanger plates within the double fold. Construction methods that use a single fold, or glue at the leading and trailing edges of the exchanger are not acceptable.
E. The air-to-air plate exchanger core shall be assembled into a strong, self-supporting frame made of aluminum corner extrusions and 20 gauge galvanized steel end plates.
F. The corners of the assembled exchanger package and the inside of the double folded seams shall be sealed with synthetic casting resin.
G. The aluminum corner extrusions shall be hollow to accept mounting screws and shall provide a 45° corner support angle.
H. The air-to-airplate exchanger package with synthetic resin sealed corners shall be resistant to temperatures up to 194°F (90°C).
I. The air-to-air plate exchanger shall withstand, without significant change in its performances and pressure drops, a pressure differential of at least 6" w.g.. It shall withstand a pressure differential of 10" w.g. without permanent deformation.
J. See Schedule for Performance Data.

2.06 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. 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")) (Dwyer Model #2002 (0" to 2")). Provide all necessary copper or aluminum tubing and mounting hardware to install gauge(s).

2.07 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.
B. Construction Requirements:
    1. Extruded aluminum frame. Insulated on all four sides.
    2. Extruded aluminum blades internally insulated.

3. Blade seals end seals and frame seals shall be fabricated from extruded silicon and be secured in and integral slot with the aluminum extrusion.
4. Bearings; inner celcon bearing and outer polycarbonate bearing.
5. Shaft; Hexagon shaped with inner and outer bearing.
6. Maximum 48" unsupported blade length. Furnish dampers wider than 48" in sections bolted together and connected such that all blades operate smoothly and simultaneously.

C. Performance Requirements:
1. Rated for duty from -40 deg F to 200 deg F.
2. Maximum 5 cfm per square foot air leakage at 1" W.C. differential static pressure.
3. Assembly shall have insulating factory of R=2.29 and temperature index of 55.

2.08 ROTARY AIR-TO-AIR ENERGY RECOVERY WHEEL SECTION

A. Certified in accordance with AHRI 1060 (I-P) and UL 1812 for mechanical, electrical, and fire safety.

B. Casing:
1. Galvanized steel, stainless steel, or aluminum with standard factory finish.
2. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch differential pressure.
3. Casing seals on periphery of rotor and on duct divider and purge section.
4. Support vertical rotors on grease-lubricated ball bearings having grease fittings. Support horizontal rotors on tapered roller bearing.

C. Rotor: Aluminum, metallic, or polymer segmented wheel strengthened with radial spokes impregnated with nonmigrating, water-selective, 3-angstrom, molecular-sieve desiccant coating.

D. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable frequency controller and self-adjusting multilink belt around outside of rotor.
1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section "Common Motor Requirements for HVAC Equipment."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

E. Controls:
1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
a. Variable-Frequency Controller with Exhaust- and Outdoor-Air Sensors: Factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat and set-point adjuster, to vary rotor speed and maintain exhaust temperature above freezing and air differential temperature above set point. Rotor speed shall increase to maximum when exhaust- air temperature is less than outdoor-air temperature.
b. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
2. AHRI 1060 Certification: Testing according to AHRI 1060 and listed and labeled by AHRI.
3. Install heat wheels so supply and exhaust airstreams flow in opposite directions and rotation is away from exhaust side to purge section to supply side.
a. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.
b. Provide access doors and panels as specified.

2.09 AIR-TO-AIR DESICCANT DEHUMDIFICATION WHEEL

A. Casing:
1. Galvanized steel, stainless steel, or aluminum with standard factory finish.
2. Support vertical rotors on grease-lubricated ball bearings having grease fittings. Support horizontal rotors on tapered roller bearing

B. Rotor: Wound Silica Gel durable media, infused with silica gel:
1. Adjustable full contact silicon bulb seal preventing air leakage for differential pressures up to 8" wc.

C. Drive: Fractional horsepower motor and heavy duty gear reducer, with speed changed by variable frequency controller and chain drive and tensioner that eliminates wheel slippage.
1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section "Common Motor Requirements for HVAC Equipment."

2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

D. Controls:
   1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
   2. Variable-Frequency Controller controllable to maintain supply dew point set point by varying speed.

2.10 AIR BLENDER SECTION

A. Provide air blenders with mounting frames, as indicated.
   1. Factory manufactured air blenders to be constructed of heavy gauge aluminum, all welded construction.
   2. Devices to be completely fixed, capable of providing:
      a. Mixed air temperature within 6 degrees F of theoretical mixed air temperature.
      b. Uniform air velocity contour entering a coil bank.

2.11 VARIABLE FREQUENCY DRIVE

A. Refer to section 23 09 13 on requirements for variable frequency drives.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Bolt sections together with gaskets.
C. Provide fixed sheaves required for final air balance.
D. Make connections to coils with unions or flanges.
E. 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.
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.

3.02 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements for additional requirements.
B. Coordination of Other Tests and Inspections:
   1. Owner will employ independent Testing, Adjusting, and Balancing agency to test and/or inspect modular central-station air handling-unit.
   2. Provide access and _____ as required to accommodate timely performance.
   3. See Section 23 0593.

3.03 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.

3.04 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals for closeout submittals.
B. See Section 01 7900 - Demonstration and Training for additional requirements.
C. Demonstrate proper operation of equipment to Owner's designated representative.
D. 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.

END OF SECTION

SECTION 23 7413 - PACKAGED OUTDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Packaged roof top unit.
B. Roof mounting curb and base.
C. Maintenance service.

1.02 RELATED REQUIREMENTS

A. Section 07 7200 - Roof Accessories: Placement and installation of factory fabricated roof mounting curbs.
B. Section 23 0913 - Instruments and Control Elements: Control components, time clocks.
C. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.

1.04 SUBMITTALS

A. See Section 01 3000 - 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 6000 - Product Requirements for additional provisions.
        b. Extra Filters: Two sets for each unit.

1.05 QUALITY ASSURANCE

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

1.06 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.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
B. Provide a five year warranty to include coverage for refrigeration compressors.

PART 2 PRODUCTS

2.01 ROOF TOP HEATING AND AIR CONDITIONING UNITS:

A. Each unit shall be a complete chilled water coil with hot water heat unit with low matching component parts designed specially for roof top installation. Each unit shall contain chilled water 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 a suitable roof mounting frame to be supported by a structural steel frame provided by the contractor. 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 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.

C. All piping connections to the unit shall be made inside an enclosed pipe vestibule. Piping vestibule shall be of the same construction as the unit walls. Piping entering the vestibule from below shall rise inside an extension of the unit curb.
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. Hot water coils shall be installed in the units and rated for 40% glycol/water mixture. The coils shall meet the performance as scheduled.
H. Cooling coils shall be installed in the units and shall be rated for 40% ethylene glycol/water mixture. The coils shall meet the performance as scheduled.
I. 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.
J. The heat recovery section shall be provided with a motor for the heat wheel and all required bypass dampers.
K. Unit shall be mounted on a factory furnished 24" acoustical style solid bottom roof curb, fully lined 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.
L. 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.
M. Controls shall be DDC by controls contractor.
N. 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 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.
O. Unit shall be furnished by the manufacturer with smoke detectors mounted in the supply and exhaust duct openings. Detectors shall be wired to shut down unit upon activation. Provide contact points to allow signal to be sent to the building fire alarm system that the detectors have been activated.
P. 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.
Q. Roof top units shall be furnished as scheduled on the drawings.

R. Variable frequency drives (VFD) shall be furnished with the unit in accordance with the specifications found in Section 23 09 13. VFDs mounted on the exterior of any units shall be furnished with NEMA 3 enclosures.
S. Motors of roof top heating and air conditioning units requiring variable frequency drives shall be provided with a shaft grounding system as required to prevent shaft current. 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.
T. All access doors shall be a minimum of 18" wide.
U. Acceptable manufacturers shall be Temtrol or an approved equal.

PART 3 EXECUTION

3.01 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.

3.02 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.
E. 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.

3.03 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.

3.04 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals for closeout submittals.
B. See Section 01 7900 - Demonstration and Training for additional requirements.
C. Demonstrate operation to Owner's maintenance personnel.

3.05 MAINTENANCE

A. See Section 01 7000 - Execution and Closeout Requirements for additional requirements relating to maintenance service.
B. Provide service and maintenance of packaged roof top units for one year year from Date of Substantial Completion.
C. Provide routine maintenance service with a two month interval as maximum time period between calls.
D. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibration.
E. After each service call, submit copy of service call work order or report that includes description of work performed.

END OF SECTION

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SECTION 23 7433 - DEDICATED OUTDOOR AIR UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Indoor-mounted DOAS.

1.02 RELATED REQUIREMENTS

A. Section 23 0513 - Common Motor Requirements for HVAC Equipment.
B. Section 23 0934 - Variable-Frequency Motor Controllers for HVAC.
C. Section 23 8216 - Air Coils: Water or steam coil requirements.
D. Section 25 1400 - Integrated Automation Local Control Units.
E. Section 25 1500 - Integrated Automation Software: BAS, BMS, or SCADA.
F. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 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 - Sound Performance Rating of Outdoor Unitary Equipment; 2015, with Addendum (2016).
C. ASHRAE Std 23 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Compressor Units; 2022.
D. 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.
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. UL (DIR) - Online Certifications Directory; current listings at database.ul.com.
G. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Shop Drawings:
    1. Product Data: Provide data with dimensions, duct and service connections, accessories, controls, electrical nameplate data, and wiring diagrams.
    2. Indicate dimensions, duct and service connections, accessories, controls, electrical nameplate data, and wiring diagrams.
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. Project Record Documents: Record actual locations of components.
    4. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
        a. See Section 01 6000 - Product Requirements for additional provisions.
        b. Extra Filters: One set of each type and size.

1.05 QUALITY ASSURANCE

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

1.06 REGULATORY REQUIREMENTS

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

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.
B. Provide five year manufacturers warranty for compressor/condenser unit.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Applied Air, a company of Mestek, Inc
B. CaptiveAire Systems
C. Greenheck
D. York a brand of Johnson Controls International, Plc; _____: www.york.com/#sle.
E. Daikin.
F. Substitutions: See Section 01 6000 - Product Requirements.

2.02 INDOOR-MOUNTED DOAS

A. Packaged Unit:
    1. Casing and Components:
        a. Fabrication: AHRI 210/240 and UL 207 construction, ASHRAE Std 23 tested.
        b. 18 gauge, 0.0478 inch steel panels reinforced with structural angles and channels to ensure rigidity.
        c. Provide bolted access panels to access each sections from either side of unit.
        d. Provide hinged door with lockable handle for serviceable sections.
        e. Drain Pan: Galvanized steel with corrosion-resistant coating.
    2. Performance Ratings: ASHRAE Std 90.1, EER and COP as applicable.
    3. Regulatory Requirements: AHRI 270 rated, NFPA 70, and UL (DIR) listed.
    4. Insulation: Minimum 1/2 inch thick acoustic duct liner for lining cabinet interior.
    5. External Surface Finish: Heat resistant baked enamel.
B. Filter Section:
    1. Filter: Removable, 2 inches thick MERV-8.
C. Heating Section:
    1. Hot Water Coil:
        a. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.
        b. See Section 23 8216 for specific coil manufacturing requirements.
D. Cooling Section:
    1. Chilled Water:
        a. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.
        b. Provide capillary tubes or thermostatic expansion valves for units of 6 Tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 Tons cooling capacity and larger.
E. Fan Section:
    1. Provide direct or plenum mounted variable-speed fan motors; see Section 23 0513.
    2. Draw-through, forward-curved fan, constructed of corrosion-resistant, galvanized material and designed for efficient, quiet operation.
    3. Factory program for both soft start and constant flow output over static pressure range.
    4. Provide preinstalled neutral wire protection when required to support specified fan type.
    5. Motor to include thermal overload protection, quick disconnect plug, and permanently lubricated bearings.
    6. Belt-Driven Motor Requirements: Provide adjustable blower motor/sheave combination device based on indicated flow performance requirements. Statically and dynamically balanced centrifugal fan mounted on solid steel shaft with heavy-duty, self-aligning, prelubricated ball bearings and V-belt drive with matching motor sheaves and belts.
    7. Variable Speed Control: Configure controller to maintain adjustable flow setpoint for modulating or speed-switched units; see Section 23 09 13.
    8. Fan Turndown: Design control features to allow fan speed reduction to adjustable 50 percent of its capacity when the zone set point temperature is satisfied or when unit runs in fan-only mode.
F. Unit Controls:
    1. DDC:
        a. Application Specific Controller; see Section 25 1400 unless factory-provided.

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b. Tested to monitor and handle sequencing functions and other operational modes using field-mounted thermostat and other sensors.
c. Coordination and Sequencing:
1) Internal Devices: Include compressors, blower, sensors, switches, valves, safeties, other components.
2) Field-Installed Devices: Solenoid valves, thermostat, EWT sensors, LWT sensors, internal and remote contacts, and other devices required for operation.
3) Safeties: At minimum include anti-short-cycle compressor protection, condensate overflow, refrigerant high pressure, refrigerant low pressure, loss-of-charge, refrigerant freeze protection, and freezestat.

2. Thermostat:
a. Field mounted and wired, tied into prewired control-interface terminals.
b. Smart Thermostat:
1) BAS, SCADA, or Integrated Automation linked programmable thermostat; see Section 25 1400.
c. Programmable Thermostat:
1) Electro-mechanical type with key- or pushbutton-operated display.
2) Programmable occupied/unoccupied weekly and holiday schedule.
d. Nonprogrammable Thermostat:
1) Electro-mechanical type with key- or pushbutton-operated display.
2) User-configurable, precoded options aligned with equipment functions.
e. Thermostat: Single-gang-box-mounted platinum or thermistor.
1) Local Interface to Include:
(a) Filter maintenance indicating status.

3. Local Control Panel: Interface to include on-off-auto switch, summer-winter switch, heat-off-cool switch, indicating lights for supply fan, pilot operation, burner operation, lockout indication, and clogged filter indication.

G. Electrical: 480 VAC, 3-phase, 60 Hz, single point to factory-mounted nonfused disconnect switch internally wired into motors and compressors, and other powered components including system safeties.
H. Furnish dedicated outdoor air unit and associated components and accessories produced by a single manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Connect drain pan outlet to nearest building drain system piping.
C. Adjusting: Use plenum static pressure readings against manufacturer calibration chart to adjust primary airflow as other measuring methods will not work.
D. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 25 1500.
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.

3.02 MAINTENANCE

A. See Section 01 7000 - Execution and Closeout Requirements for additional requirements.
B. Provide service and maintenance of units for one year from Date of Substantial Completion.

END OF SECTION

SECTION 23 8200 - CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hydronic finned tube radiation.
B. Hydronic unit heaters.
C. Hydronic cabinet unit heaters.
D. Fan-coil units.

1.02 REFERENCE STANDARDS

A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); Current Edition.
B. AHRI 440 - Performance Rating of Room Fan-Coils; 2008.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
D. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.

1.03 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 6000 - Product Requirements for additional provisions.
        b. Extra Filters: Two sets of each type and size.

PART 2 PRODUCTS

2.01 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.
    5. Sigma www.sigmaproducts.com.
    6. Substitutions: See Section 01 6000 - Product Requirements.
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 or aluminum as detailed, 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. Damper: Where not thermostatically controlled, provide knob-operated internal damper at enclosure air outlet.
H. Access Doors: For otherwise inaccessible valves, provide factory-made permanently hinged access doors, 6 by 7 inch minimum size, integral with cabinet.
I. Fin radiation installed behind cabinet work shall be furnished less cover.

2.02 HYDRONIC UNIT HEATERS

A. Manufacturers:
1. Rittling. www.zehnder-rittling.com
2. Sterling Hydronics, a Mestek Company: www.sterlingheat.com.
3. Vulcan. www.vulcanrad.com
4. Trane Technologies, PLC; _____: www.trane.com/#sle.
5. Sigma. www.sigmaproducts.com
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.
H. Conrol:Room thermostat specified elsewhere in the specifications.

2.03 HYDRONIC CABINET UNIT HEATERS

A. Manufacturers:
1. Rittling. www.zehnder-rittling.com
2. Sterling Hydronics a Mestek Company: www.sterlingheat.com.
3. Vulcan. www.vulcanrad.com
4. Sigma. www.sigmaproducts.com
5. Trane Technologies, PLC; _____: www.trane.com/#sle.
6. Substitutions: See Section 01 6000 - Product Requirements.

B. Coils:
1. Evenly spaced aluminum fins mechanically bonded to copper tubes.

C. Finish: Factory applied baked enamel of color as selected on visible surfaces of enclosure or cabinet.
D. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.
E. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted with built-in thermal overload protection.
F. 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.
G. Filter: Easily removed, 1 inch thick glass fiber throw-away type, located to filter air before coil.
H. Controls:
1. Room thermostat equal to Room thermostat specified elsewhere in the specifications.

2.04 FAN-COIL UNITS

A. Manufacturers:

1. Vertical Cabinet, Horizontal Exposed, or Horizontal Recessed:
    a. Daikin Applied: www.daikinapplied.com.
    b. Dunham Bush https://www.dbamericas.com
    c. Trane, a brand of Ingersoll Rand: www.trane.com.
    d. Substitutions: See Section 01 6000 - Product Requirements.

B. Performance Data and Safety Requirements:
1. Unit capacities certified in accordance with AHRI 440.
2. Insulation to comply with NFPA 90A requirements for flame spread and smoke generation.
3. Equipment wiring to comply with requirements of NFPA 70.
4. All units shall be quiet operating at high speed.

C. Required Directory Listings: AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI).

D. Coils:
1. Units shall be two pipe/four pipe as scheduled and shall have seperate coils for heating and cooling. A drain pan shall be provided beneath coil(s) and an extension or secondary drain pan shall be provided beneath the control valve and connections. The drain pan shall be equipped with a secondary drain pipe connection and a condensate overflow switch to automatically shut down the unit upon high water detection.
2. Evenly spaced aluminum fins mechanically bonded to copper tubes.
3. Provide drain pan under cooling coil easily removable for cleaning.

E. Finish: Exposed units shall have factory applied baked enamel of color as selected on visible surfaces of enclosure or cabinet.

F. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.

G. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted. Three-speed switches shall have "Off" position.

H. Controls:
1. Ceiling hung units shall be furnished with remote speed control switch.
2. Provide units with control valves furnished by the automatic temperature controls manufacturer.

I. Filter: Easily removed 1 inch thick permanent washable type, located to filter air before coil. Provide two (2) extra filters at the end of the job.

PART 3 EXECUTION

3.01 INSTALLATION

A. 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.

B. 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.

C. Cabinet Unit Heaters:
1. Coordinate installation with architect.
2. Coordinate to ensure correct recess size for recessed units.

D. Fan-Coil Units:
1. Install as indicated.
2. Coordinate to ensure correct recess size for recessed units.

3.02 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 8241 - WATER-TO-WATER HEAT PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Heat Recovery Chiller.

1.02 RELATED REQUIREMENTS

A. Section 23 0529 - Hangers and Supports for HVAC Piping and Equipment.
B. Section 23 0548 - Vibration and Seismic Controls for HVAC.
C. Section 26 0583 - Wiring Connections.

PART 2 PRODUCTS

2.01 HEAT RECOVERY CHILLER

A. Chiller shall incorporate (3) modules; each with (2) scroll-type compressors (the lead circuit shall have a variable speed compressor) and consist of (2) individual refrigerant circuits. Each refrigerant circuit shall consist of an individual compressor, condenser, evaporator, thermal expansion valve, and control system (a reversing valve shall NOT be installed in the refrigeration circuit). Each circuit shall be constructed to be independent of other circuits from a refrigeration and electrical stand-point.
B. Refrigerant shall be R-454B.
C. The manufacturer against defects in materials and workmanship shall warrant the units for a period of one year on all parts with labor costs included. An additional four-year warranty covering the compressor and major parts shall be provided, with labor costs included.
D. The cabinet shall be fabricated from heavy-gauge no-lead galvanized steel with clear acrylic coating. The interior shall be insulated with 1" thick 1-1/2 lb multi-density, skin-coated fiberglass. The chiller shall be provided with a sound package that consists of sound dampening panels that totally enclose the modules. The sound package provided with the chiller shall reduce the sound pressure levels measured at 1 meter at a minimum of 12 decibels.
E. Chiller modules shall be single package heating/cooling units. Units shall be listed by a nationally recognized safety-testing laboratory or agency, such as ETL Testing Laboratory or Canadian Standards Association (CSA). Each unit shall be computer run-tested at the factory and shall be pallet mounted and shipped in a corrugated box.
F. Units shall be supported from the base pan with mounting brackets and rubber-in-shear vibration isolators furnished by the manufacturer. 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 all bearing points. Pads shall be a minimum of 6" wide by 6" long by 3/4" thick.
G. Modules shall ship wired and charged with refrigerant. All modules shall be factory run tested prior to shipment on an AHRI certified or 3rd party verified test stand.
H. Compressors, heat exchangers, piping and controls shall be mounted on a heavy gauge steel frame. Electrical control, contactors, and relays for each module shall be mounted within that module.
I. All controls shall be factory installed and wired within the air conditioner. Heat recovery chiller shall be enabled/disabled by the DDC system as shown on the temperature control drawings.
J. Each module shall include supply and return mains for both chilled and condenser water. Each evaporator and condenser shall be brazed plate heat exchangers constructed of 316 stainless steel, designed and tested for 650 psig working pressure on the condenser. Both the condenser and evaporator heat exchanger shall be factory insulated.
K. Flow switches shall be provided by equipment manufacturer and field installed and wired by mechanical contractor on both the evaporator and condenser.
L. Each module shall contain scroll compressors (variable speed compressor on the lead circuit) independently circuited and with internal spring isolation mounted to the module with rubber-in-shear isolators. Each system also includes high discharge pressure and low suction pressure manual reset safety cut-outs.
M. Scheduling of the compressors shall be performed by a microprocessor based control system. A new lead compressor is selected every 24 hours to assure even distribution of compressor run time.
N. The unit controller shall monitor and report the following on each refrigeration system: Discharge Pressure Fault, Suction Pressure Fault, Compressor Winding Temperature, Suction temperature and Evaporator Leaving Chilled

Water Temperature. The unit controller shall be powered by the chillers single point power connection and shall monitor and report the following system parameter: Chilled Water Entering and Leaving Temperatures, Condenser Water Entering and Leaving Temperatures, Chilled Water and Condenser Water Flow Status.

O. Individual monitoring of leaving chilled water temperatures from each refrigeration system shall be programmed to protect against freeze-up.

P. The control system shall monitor entering and leaving hot and chilled water temperature to determine system load and select the load required for each compressor to operate. Response times and set points shall be adjustable. The system shall provide a variable time between compressor sequencing and temperature sensing, so as to fine tune the chiller and different building conditions.

Q. The chiller shall be capable to interfacing with the building automation system using an Interoperablity Web Portal and shall be capable of communication over BACNet. Provide BACNet integration card and components for integrating with the building automation system.

R. Chiller shall have single point power connection and external inputs and outputs to be compatible with the building automation system.
   1. Remote Start/Stop.
   2. Customer Alarm Relay.
   3. Customer Hot/Chilled/Load Limit Reset Signal.
   4. Entering Hot Water to Mechanical Cooling Module.
   5. Leaving Hot Water from Mechanical Cooling Module.
   6. Entering Chilled Water to Mechanical Cooling Module.
   7. Leaving Chilled Water to Mechanical Cooling Module.
   8. Power Phase Monitor.
   9. Chilled Water Flow Switch Input.
   10. Condenser Water Flow Switch Input.
   11. Full Load Indicator Relay.
   12. Condenser Pump Relay.
   13. Chilled Water Pump Relay.

S. Each inlet water header shall incorporate a built-in 30-mesh in-line strainer system to prevent heat exchanger fouling and accommodate 100% flow filtration with minimum surface area of 475 sq. inches per module.

T. Chiller shall be equipped with a pre-engineered genuine buss bar electrical system for single point power rated at 10,000 amp SCCR.

U. 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.

V. Units manufactured by Jetson or an approved equal shall be accepted. It shall be the responsibility of the heat pump manufacturer to verify the differences between the proposed units and the units scheduled and shown on the drawings. While slight differences in performance will be accepted, variations in, piping arrangement, pipe sizes, valves, fittings, connection locations, and electrical characteristics and the resulting additional installation work shall be the responsibility of the alternate manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's written installation instructions.

B. Unit Mounting:
   1. Ground or Surface-Mount: Include vibration-isolated support base; see Section 23 0548.
   2. Above Finished Floor: Include hangers and supports; see Section 23 0529.
   3. Do not obstruct maintenance access to equipment by any type of piping, electrical conduit, or any other utility.

C. Electrical: Provide equipment raceway, wiring, and cables; see Section 26 0583.

D. Start system and adjust controls and equipment for satisfactory operation.

E. Adjust water temperature control system and place in operation so that water quantities circulated are as required.

END OF SECTION

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SECTION 23 8300 - RADIANT HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hydronic radiant panel heaters.
B. Radiant heating hydronic piping.

1.02 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. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing; 2020b.
E. ASTM F1807 - Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Cross-Linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing; 2023.
F. 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.
G. 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.

1.03 SUBMITTALS

A. See Division 01 – Administrative Requirements, for submittal procedures.
B. Shop drawings:
    1. Materials and layout.
    2. As part of the submittal for the radiant floor heat piping and accessories, a tubing layout drawing shall be provided to the engineer for review indicating number of loops, tube spacing, manifold location, and tube routing.
    3. 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.

1.04 QUALITY ASSURANCE

A. Radiant Slab Heat Tubing:
    1. Deliver materials in manufacturer’s original, unopened, undamaged containers with identification labels intact. Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.
        a. Store PEX tubing in cartons or under cover to avoid dirt or foreign material from entering the tubing.
        b. Do not expose PEX tubing to direct sunlight for more than 30 days. If construction delays are encountered, cover the tubing that is exposed to direct sunlight.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Radiant heat tubing system:
    1. Manufacturer’s Warranty: Submit, for Owner’s acceptance, manufacturer’s standard warranty document executed by authorized company official. Manufacturer’s warranty is in addition to, and not a limitation of, other rights Owner may have under contract documents.
        a. Warranty covers the repair or replacement of any tubing or fittings proven defective.
        b. Warranty Period for PEX Tubing: 25-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion when installed by a factory-trained contractor.
        c. Warranty Period for Manifolds and Fittings: 5-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion when installed by

a factory-trained contractor.

d. Warranty Period for Controls and Electrical Components: 2-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion when installed by a factory-trained contractor.

PART 2 PRODUCTS

2.01 HYDRONIC RADIANT PANEL HEATERS

A. Manufacturers:
   1. Aero Tech
   2. Air Tex
   3. Airtite
   4. TWA
   5. Sigma
   6. Substitutions: See Section 01 6000 - Product Requirements.

B. Modular Radiant Ceiling Panels: Heat sinks located behind panel, transfer heat between copper tubes and panel face, and radiate heat to zone.
   1. Performance:
      a. The radiant-acoustical panels shall produce a minimum heating output of 135 BTU per hours per sq. ft. at 165° F mean water temperature (M. W. T.) in a room with 79°F air temperature, 70°F average unheated surface temperature, medium construction of roof above, and natural air motion. Panels installed in exterior zone spaces with sunlight glass shall produce a minimum absorption rate of 45 BTU per hour per sq. ft. at a M. W. T. of 19.5°F below room temperature of 78°F, when 25% of the wall is glass.
   2. Modular configuration:
      a. Frame type: Lay-in
      b. Basis of design - Airtex Radiant Modulpanels
      c. Size: 24" x 48" x 0.40" thick.
      d. 3/4 lb. density glass fiber pads, Gustin-Bacon Ultralite 75, or equal
   3. Water Tubes:
      a. ASTM B75/B75M copper tubing, 1/2 inch minimum nom29 CFR 1926inal diameter.
      b. Water Connections:
         1) Suitable for solder or compression fittings.
         2) Protect with removable seals. Prevent introduction of dirt and dust during shipping.
   4. 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.
   5. Panel Face: Construct of minimum 18 gauge, 0.0403 inch thick aluminum.
   6. Finish:
      a. Panels shall be block perforated and silk screened to match ceiling.
      b. Color: As selected by Architect from manufacturer's standard range.
      c. Maintain optimal radiative properties, durability, and cleanability.
   7. Water Pressure Drop and Heating Output Data: Derive from factory testing in accordance with ASHRAE Std 138 or DIN 14037, Parts 2 and 3.

2.02 RADIANT-HEATING HYDRONIC PIPING

A. Applications:
   1. Provide the following types of hydronic, radiant heating piping for the applications described:
      a. Piping in Exterior Pavement: PEX.
      b. Piping in Interior Reinforced Concrete Floors: PEX.

B. Crosslinked Polyethylene (PEX) Pipe and Fittings:
   1. Manufacturers:
      a. HeatLink
      b. Mr. Pex.
      c. Rehau.

d. Uponor, Inc. (Wirsbo)
e. Substitutions: See Section 01 6000 - Product Requirements.

2. Pipe Material: PEX plastic according to ASTM F876. Pex-A or Engle method.
3. Performance Requirements: Provide hydronic radiant floor heating system that is manufactured, fabricated and installed to comply with regulatory agencies and authorities with jurisdiction, and maintain performance criteria stated by the PEX tubing manufacturer without defects, damage or failure.
4. Show that all piping installed complies with current codes and required UL listings.
5. Minimum Bend Radius (Cold Bending): No less than six times the outside diameter. Use the PEX tubing manufacturer's bend supports if radius is less than stated.
6. Fittings: ASTM F1807, metal insert and copper crimp rings.
7. Design Requirements
   a. Standard Grade hydrostatic pressure ratings from Plastics Pipe Institute in accordance with TR-3 as listed in TR-4. The following three standard-grade hydrostatic ratings are required.
      1) 200 degrees F (93 degrees C) at 80 psi (551 kPa)
      2) 180 degrees F (82 degrees C) at 100 psi (689 kPa)
      3) 73.4 degrees F (23 degrees C) at 160 psi (1102 kPa)

C. Distribution Manifolds: residential and light commercial, valved brass.
1. Residential and light commercial:
   a. For system compatibility, use 1¼-inch brass manifolds offered by the respective PEX tubing manufacturer.
   b. Manifolds must provide individual shutoff and balancing valves for each loop of the manifold.
2. All pipe fittings shall be by the same manufacturer as the tubing.
3. Manifold Box:
   a. Provide a galvanized steel minimum 20 gauge enclosure box protecting the manifolds and the tubing where it comes out of the floor. Locate where directed.
4. Main Shutoff Valves:
   a. Factory installed on supply and return connections.
   b. Two-piece brass or bronze body.
   c. Ball: Chrome-plated bronze.
   d. Seals: PTFE.
   e. CWP Rating: 150 psig.
   f. Maximum Operating Temperature: 225 degrees F.
5. Manual Air Vents:
   a. Body to consist of bronze or brass.
   b. Internal Parts: Nonferrous.
   c. Operator: Key furnished with valve or screwdriver bit.
   d. Inlet Connection: 1/2 inch.
   e. Discharge Connection: 1/8 inch.
   f. CWP Rating: 150 psig.
   g. Maximum Operating Temperature: 225 degrees F.
6. Balancing Valves:
   a. Body: Provide bronze, plug or globe cartridge type.
   b. Plug: EPDM.
   c. Globe Cartridge and Washer: Brass with EPDM composition washer.
   d. Seat: PTFE.
   e. Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.
   f. Differential Pressure Gauge Connections: Integral seals for portable meter to measure loss across calibrated orifice.
   g. Handle Style: Knob, with memory stop to retain set position if used for shutoff.
   h. CWP Rating: Minimum 125 psig.
   i. Maximum Operating Temperature: 250 degrees F.
7. Zone Control Valves:

a. Body: Provide brass or bronze, plug or globe cartridge type.
b. Plug: EPDM.
c. Globe Cartridge and Washer: Brass with EPDM composition washer.
d. Seat: PTFE.
e. Actuator: Replaceable electric motor.
f. CWP Rating: Minimum 125 psig.
g. Maximum Operating Temperature: 250 degrees F.

8. Thermometers:
a. Mounted on supply and return connections.
b. Case: Dry type, metal or plastic, 2 inch diameter.
c. Element: Bi-metallic coil.
d. Movement: Mechanical, connecting element and pointer.
e. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
f. Pointer: Black metal.
g. Window: Plastic.
h. Connector: Rigid, back type.
i. Thermal System: Bi-metallic coil.
j. Accuracy: Plus or minus 1 percent of range to maximum of 1.5 percent of range.

9. Mounting Brackets: Provide copper, where in contact with manifold.

D. Snow melt radiant heating controls:
1. The control panel for the snow melt system shall be equal in capabilities to the Wirsbo SNOWpro 411. The control system shall be a fully automatic snow and ice melting control that responds to changing weather conditions. It shall provide a one-temperature reset using a variable speed injection pump. The system shall include a snow and ice detector. The detector senses the presence of moisture on the surface of the slab. It also monitors the slab temperature.
2. Snow Melt System Operation:
a. This control strategy for snow and ice melting shall be totally automatic control of idle and snow-melt operations. Control strategy and components shall be installed to meet or exceed the system performance requirements as stated herein.
b. A variable speed injection pump, controlled by the system shall temper the supply fluid temperature based on the snow melt needs and outdoor conditions.
c. The Snow and Ice Detector monitors the presence of moisture on the sensor (snow-melt mode) and slab temperature.
d. The system shall reset the supply water temperature as it relates to outdoor temperature. Install the outdoor temperature sensor on the east side of the stairs with a non corrosive cover to keep the sensor out of direct sunlight.
e. The run time shall be programmable from 30 minutes to 17 hours. It shall also be capable of being programmed to infinity as it will operate in snow-melt mode as long as there is moisture present on the sensor.
f. The system shall be capable of idling the snow-melt slab at a given temperature and automatically accelerate to a higher supply fluid temperature during snow-melting mode.
g. The system shall automatically switch from snow-melt mode to idle mode once the snow and ice detector indicates the lack of moisture on the sensor.
h. The system shall activate the system circulator.
i. The system shall activate the variable speed injection pump.
j. The system shall activate the snow melt pump.
k. For proper operation of the control, install the outdoor sensor, the system supply sensor, the return sensor, the snow-melt return sensor and the snow and ice detector.

3. Provide all piping, wiring, and conduit for a complete operating system. The controls for this system shall be the responsibility of this contractor.

E. Controls:
1. Thermostats shall be specified under temperature control.

PART 3 EXECUTION

3.01 EXAMINATION

A. Hydronic Radiant Heating Piping:
   1. Examine surfaces and substrates to receive radiant heating piping for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
      a. Ensure that surfaces and pipes in contact with radiant heating piping are free of burrs and sharp protrusions.
      b. Ensure that surfaces and substrates are level and plumb.
   2. Proceed with installation only after unsatisfactory conditions are corrected.

3.02 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. Provide tamper-proof, balancing valve with memory stop on return piping.
   6. Provide float operated automatic air vents with stop valve.
   7. Circuiting of panels shall be such as to limit pressure loss across the individual controlled panel zone to 10 feet W.C., or less.
C. Hydronic Radiant Heating Piping:
   1. **This contractor shall provide and install 2" thick, R-10, 60psi polystyrene insulation similar to Owens Corning Foamular 600, high compression strength rigid foam insulation below all floor heating piping. Insulation shall extend 12" beyond the perimeter of the piping. Coordinate installation with general contractor.**
   2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
   3. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
   4. Comply with manufacturer's product data, including product technical bulletins, installation instructions and design drawings.
   5. Install piping as indicated unless deviations to layout are approved on shop drawings or coordination drawings.
   6. Install radiant heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.
   7. Connect radiant piping to manifold in a reverse-return arrangement.
   8. Do not bend pipes in radius smaller than manufacturer's minimum bend radius dimension.
   9. Slab on grade installation:
      a. Maintain minimum 40 psig pressure in piping during concrete placement and continue for 24 hours after placement.
      b. Fasten the tubing to the flat mesh or reinforcing bar in accordance with the PEX tubing manufacturer's installation recommendations.
      c. Use closer tubing on-center distances along exterior walls. Increase tubing on-center distances as the installation moves away from the exterior wall as noted on plans
      d. When using high-density board insulation, staple the tubing to the insulation board with Foam Staples.
      e. Use edge insulation when the heated panel directly contacts an exterior wall or panel.

f. Install tubing at a consistent depth below the surface elevation as determined by the project engineer. Ensure sufficient clearance to avoid control joint cuts.
g. In areas where tubing must cross metal expansion joints in the concrete, ensure the tubing passes below the joints. Depending on the manufacturer's and structural engineer's recommendation, fibrous expansion joints may tolerate penetration.

10. Glycol and Water Solution: PEX tubing shall be rated for the amount of 50% of propylene glycol specified for the heating system.
11. Installation of the in-floor radiant heating system shall be supervised by a factory trained representative. After the radiant panel heating system has been fabricated and installed, and before floor has been poured, the entire system shall be subjected to a hydraulic test of not less than 125 psi. The system shall be filled with water, all air vented out and a hydraulic pressure applied for a minimum of four hours. If leaks are found they shall be sealed and the pressure retested until the installation will hold pressure for at least four hours. If system is to be tested during winter months, contractor shall furnish temporary heat to insure space temperature above freezing during the test and shall take necessary precautions to insure no danger of freezing after the test.
12. Piping in Exterior Pavement:
    a. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
    b. Space cable ties a maximum of 18 inches and at center of turns or bends.
    c. Maintain 3 inch minimum cover.
    d. Glycol and Water Solution: PEX tubing shall be rated for the amount of 50% of propylene glycol specified for the heating system.
    e. Install a sleeve of 3/8 inch thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints.
        1) Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
    f. Maintain minimum 40 psig pressure in piping during concrete placement and continue for 24 hours after placement.
    g. Installation of the in-floor radiant heating system shall be supervised by a factory trained representative. After the radiant panel heating system has been fabricated and installed, and before floor has been poured, the entire system shall be subjected to a hydraulic test of not less than 125 psi. The system shall be filled with water, all air vented out and a hydraulic pressure applied for a minimum of four hours. If leaks are found they shall be sealed and the pressure retested until the installation will hold pressure for at least four hours. If system is to be tested during winter months, contractor shall furnish temporary heat to insure space temperature above freezing during the test and shall take necessary precautions to insure no danger of freezing after the test.
13. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Engineer.
14. After system balancing has been completed, mark balancing valves to permanently indicate final position.
15. Perform the following adjustments before operating the system:
    a. Open valves to fully open position.
    b. Check operation of automatic valves.
    c. Set temperature controls so all zones call for full flow.
    d. Purge air from piping.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Hydronic Radiant Heating Piping:
    1. Prepare radiant heating piping for testing as follows:
        a. Open all isolation valves and close bypass valves.
        b. Open and verify operation of zone control valves.
        c. Flush with clean water and clean strainers.
    2. Perform the following tests and inspections with the assistance of a factory authorized service representative:

a. Leak Test:
1) After installation, charge system and test for leaks.
2) Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not less than 125 psig for 30 minutes
3) Repair leaks and retest until no leaks exist.

3. Execute, complete, and pass required radiant-heating piping tests and inspections to accept installed piping.
4. Prepare test and inspection reports.
5. Protect hydronic piping system from damage during construction.

3.04 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

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SECTION 26 0000 - ELECTRICAL GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical General Requirements specifically applicable to Division 26, 27, and 28 Sections.

B. Definitions common to Division 26, 27, and 28 specification sections.

1.02 RELATED DOCUMENTS

A. This section is related to all other sections of Division 26, 27, and 28.

1.03 DEFINITIONS

A. Words "Architect" where written in Division 26, 27, and 28 specifications and drawings refer to commissioned Design Professional, whose name appears on contract documents.

B. Word "Engineer" where written in Division 26, 27, and 28 specifications and drawings refers to Consulting Electrical Engineer, CMTA, Inc.; (877) 380-0501; https://www.cmta.com/contact.

C. Word "Contractor" where written in Division 26, 27, and 28 specifications and drawings refers to Electrical Contractor as described in the Division 00 and 01 bid scope document and any and all of his subcontractors.

D. Word "Furnish" where written in Division 26, 27, and 28 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.

E. Word "Install" where written in Division 26, 27, and 28 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 fittings, hangers, fastening devices, etc., as obviously necessary for a complete and operating installation.

F. Word "Material" where written in Division 26, 27, and 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.

G. Word "Labor" where written in Division 26, 27, and 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.

H. Word “Low Voltage” where written in Division 26, 27 , and 28 specifications and drawings shall mean 0 to 1,000 Volts (IEEE).

I. Word "Provide" where written in Division 26, 27, and 28 specifications and drawings shall mean 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.

J. 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

K. 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.

L. As-built drawings are prepared by the contractor. They show, in red ink, on-site changes to the original construction documents.

M. Record drawings are prepared by the Architect or Engineer and reflect on-site changes the contractor noted in the as-built drawings.

N. 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, 27, and 28 specifications Quality Assurance procedures are specified in Part 1.

O. 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, 27, and 28

specifications Quality Assurance procedures are specified in Part 3.

1.04 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.

1. 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.

E. Work under Division 26, 27 and 28 includes providing all labor and materials necessary for satisfactory completion of all electrical work shown on all drawings and in all specification divisions.

1.05 SITE INVESTIGATION

A. 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.

B. No extra charges will be allowed because of failure of Contractor to become familiar with all existing conditions.

C. 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.

D. Existing equipment, systems and installations which are not detailed on the drawings must still be restored to their original condition.

1.06 DRAWINGS

A. Drawings indicate the extent and general layout of the electrical systems.

B. The 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 all construction Drawings and Specifications for locations of partitions, walls, beams, shafts, equipment, underground ducts and wires, etc.

E. 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

1. **DO NOT SCALE LOCATIONS OF ELECTRICAL OUTLETS, LIGHT FIXTURES, OR OTHER DEVICES FROM ELECTRICAL DRAWINGS**.
2. 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.

F. 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.

1. 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, they shall notify the Engineer before proceeding with the work

G. Standard electrical symbols along with special symbols are used on all drawings.

1.07 COORDINATION

A. 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, Architect, Owner, or Consruction Manager.

B. Where discrepancies are discovered after certain portions or phases of any Contract have been installed, the Engineer, Architect, Owner, or Construction Manager may direct 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 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 providing notification.

1.08 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.

1.09 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.

1.10 WARRANTY

A. TThe 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..

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.

1.11 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.

1.12 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.
    1. Provide Products as specified unless substitutions are submitted in this manner and subsequently accepted.
B. 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.
C. 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.
D. 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.
E. 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.
F. 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.
G. 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.

1.13 DRAWING PLAN BACKGROUNDS AVAILABLE

A. Electronic drawing files may be available to the contractor for the purpose of preparing shop drawings or submittals. Files generally available after signing a waiver.

1.14 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.

1.15 PROJECT SUBCONTRACTOR AND VALUES LISTING

A. 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.
B. 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 Architect.
C. 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:
   1. Special Electrical Conditions (Bonds, Fees, Mobilization, etc.)
   2. Demolition work.
   3. Electrical service work.
   4. Structured cabling for voice / data systems.
   5. Other Division 27 systems (for expample: audio-video systems, paging systems).

6. Fire Alarm System.
7. Video surveillance system.
8. Access Control.

PART 2 PRODUCTS

2.01 NOT USED.

PART 3 EXECUTION

3.01 JOBSITE INSPECTIONS

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.

END OF SECTION

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SECTION 26 0100 - ELECTRICAL SYSTEMS CLOSE OUT DOCUMENTATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Operations and Maintenance Manuals.
B. Warranty Documentation.
C. Maintenance Materials.
D. As-Built Drawings.

1.02 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.

1.03 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.

1.04 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

2.01 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.
    3. Division 26 low voltage generator and transfer equipment.
    4. Division 27 systems.
    5. Division 28 Fire Alarm Systems.
    6. Division 28 Video Surveillance and Access Control Sytems.
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. Receipts for Spare Materials, 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. Receipts for Spare Materials, 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."

F. The Division 26 low voltage generator and transfer equipment manual shall include the following sections. See the applicable sections of the Division 26 specifications for additional information.
   1. Engine.
   2. Generator.
   3. Generator Enclosure.
   4. Fuel Tank.
   5. Control Panel.
   6. Silencer.
   7. Exhaust system.
   8. Annunciator.
   9. Circuit Breakers and accessories (lifting mechanism, racking tools, etc.)
   10. Control wiring documentation.
   11. Automatic transfer switch product data and control wiring diagrams.
   12. Receipts for Spare Materials, Owner Training / Demonstrations.
   13. Test Reports and Certificates.
   14. Operation and Maintenance Guidelines.
   15. Manufacturer's warranty statements.

G. The Division 27 structured cabling manual shall include the following sections with tabs, dividers, or other means of separating each section as well as separating each item from the next within each section. See the applicable sections of the Division 27 specifications for additional information.
   1. Cable tray.
   2. Equipment racks and cable management.
   3. Fiber cables, enclosures, terminations, etc.
   4. Copper cabling (multi-pair category 3, horizontal UTP cabling).
   5. Patch panels, 110 blocks, etc.
   6. Jacks.
   7. Receipts for Spare Materials and Owner Training / Demonstrations.
   8. Test Reports and Certificates.
   9. Operation and Maintenance Guidelines.
   10. Manufacturer's warranty statement.
   11. Contractor's Warranty Statement according to the requirements of specification "Electrical General Requirements."

H. The Division 28 Access Control System manual shall include the following sections with dividers between each section and tabs to separate each device with each divided section. See the applicable sections of the Division 28 specifications for additional information.
   1. Equipment and component operation and service manual for each make and model of equipment provided.
   2. System operation manual shall be produced for this specific project. Manual shall detail procedures necessary to activate each system. Provide a simple user guide for procedures necessary to place the system into operation.

3. Receipts for Spare Materials, Owner Training / Demonstrations.
4. Test Reports and Certificates.
5. Operation and Maintenance Guidelines.
6. Manufacturer's warranty statement.
7. Contractor's Warranty Statement according to the requirements of specification "Electrical General Requirements."

I. The Division 28 Video Surveillance System manual shall include the following sections with dividers between each section and tabs to separate each device with each divided section. See the applicable sections of the Division 28 specifications for additional information.
1. Equipment and component operation and service manual for each make and model of equipment provided.
2. System operation manual shall be produced for this specific project. Manual shall detail procedures necessary to activate each system. Provide a simple user guide for procedures necessary to place the system into operation.
3. Receipts for Spare Materials, Owner Training / Demonstrations.
4. Test Reports and Certificates.
5. Operation and Maintenance Guidelines.
6. Manufacturer's warranty statement.
7. Contractor's Warranty Statement according to the requirements of specification "Electrical General Requirements."

2.02 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 used for no other purpose.
1. 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.
2. This set of drawings shall be transmitted to the Architect as directed, and after having been examined, the set will be returned to the Contractor for further use.
3. At the completion of the project, the set of drawings shall be turned over to the Architect for approval and delivery to the Owner.

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. Indication of route of all communications backbone cabling.
4. Indicate route and location of all underground circuits, raceways, pull boxes, etc.
5. Indicate actual locations and mounting heights of outlet boxes, pull boxes, junction boxes, surface metal raceway, and wireway.
6. Final locations of all lighting control devices and diagrams showing circuiting / control wiring arrangements.
7. Provide table indicating final setting of all automatic lighting control sensors.
8. Provide document indicating final programming of relay panel.
9. Panel and Switchboard Directories: Provide revised typed directories with As-Built documents.

C. Indicate other information specifically noted in other Division 26 specification sections.

2.03 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

3.01 NOT USED.

END OF SECTION

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SECTION 26 0500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 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. 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.

D. Owner Instruction and Demonstration.

1.02 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 03 Section Cast-in-Place Concrete (Miscellaneous Cast-in-Place Concrete).

C. Section 26 01 00 Electrical Systems Close Out Documentation.

D. Division 31 for Excavation, Trenching, and Fill.

E. Division 32 for Concrete Paving.

1.03 REGULATORY REQUIREMENTS

A. See Section 26 0000.

1.04 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. 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. Costs and fees from Xcel Energy for electrical service shall be paid direclty by the Owner.

1.05 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. Equipment
1. All equipment shall be new and in first-class condition. Equipment shall not be used for purposes other than intended by the manufacturer.
2. 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.
3. 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.

H. Coordination:
1. See also "Quality Assurance" paragraph of Section 26 0000.
2. 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 with equipment and architectural, structural, mechanical, heating, ventilation element. 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
3. Discrepancies and omissions discovered during construction shall immediately be called to the attention of the Architect or Engineer for clarification.
4. 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.
5. 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.
6. 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.
7. 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.
8. Complete the entire installation as soon as building conditions permit.

9. 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.
10. 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.

I. 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.

J. 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.

K. 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

1.06 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.

1.07 SUBMITTALS

A. Submit according to the requirements of Division 01 and Section 26 0100.

B. Provide manufacturers installation instructions and product data for:
1. Fire-Resistant Joint Sealers.
2. Sleeves.

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

D. Submit written requests for System Interruptions and Outages as specified herein.

E. Include product information and installation details with O & M manuals for fire resistant joint sealers and fire resistant sleeves.

F. As-built drawings. Submit as-built drawings showing final locations of eqiupment, locations and sizes of sleeves, and rated penetrations.

PART 2 PRODUCTS

2.01 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.

2.02 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.

2.03 CONCRETE

A. Poles provided for mounting exterior light fixtures shall be installed on or in concrete bases provided by the electrical contractor as detailed on drawings.

B. 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.

C. Concrete shall conform to Division 32 specification section on Concrete Paving.

PART 3 EXECUTION

3.01 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, 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.

3.02 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. Concrete Housekeeping pad preparation: After the concrete is fully cured remove all laitance and defective or weak concret

3.03 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. 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.

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. Concrete housekeeping pads shall be installed with chamfered edges.

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. 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.

3.04 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.

3.05 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”.

3.06 TEMPORARY FACILITIES

A. The Contractor shall provide temporary facilities according to Division 01, "TEMPORARY FACILITIES".
B. Temporary power shall consist of Power Distribution Centers (PDC).
    1. Equipment shall be mounted on a ¾” plywood backboard with support legs on both ends with lockable wheels on bottom of legs so that unit is portable. Each PDC shall consist of a the following:
        a. 400 amp, 208/120 volt, 3-phase, 4-wire panelboard with distribution breakers for remote 100 amp, 208/120 volt, 1-phase, 3-wire panelboards.
        b. Six 120 volt, 20 amp, quad-plex, GFI receptacles with weatherproof box and cover, each with a dedicated circuit.
        c. Three 208 volt, single-phase, 30 amp receptacles with weatherproof box and cover.
        d. One 240 volt, single-phase, 50 amp receptacle with weatherproof box and cover.
    2. A minimum of three, 100-amp PDC shall be provided.
    3. All equipment shall be grounded per the locally-adopted version of the National Electrical Code, NFPA 70.
    4. Relocate equipment as necessary to allow construction to continue.
    5. Provide GFI protection as required by OSHA. Use GFI receptacles in lieu of circuit breakers whenever possible.
    6. Welders, temporary heat-blowers, etc. shall be hardwired as needed.
C. 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.

D. Under no condition shall permanent lighting fixtures or electric heating units be used for temporary lighting or heat, unless approved in writing by Engineer.

E. Temporary lighting and power systems shall be approved by authority having jurisdiction.

3.07 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. Electrical Distribution Equipment - provide overview of system, highlight major components and distribution equipment. Review suggested maintenance schedules.
   5. Communications System Structured Cabling Backbone System - provide overview of system, review of routing.

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.

3.08 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.

3.09 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 26 0505 - SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition.

1.02 RELATED REQUIREMENTS

A. Section 01 7000 - Execution and Closeout Requirements: Additional requirements for alterations work.

B. Section 02 8400 - Polychlorinate Biphenyl (PCB) Remediation: Removal of equipment and materials containing substances regulated under the Federal Toxic Substances Control Act (TSCA), including but not limited to those containing PCBs and mercury.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Sustainable Design Documentation: Submit certification of removal and appropriate disposal of abandoned cables containing lead stabilizers.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

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

B. Materials taken out of service: The owner shall have the first right of refusal for any materials. EC to clean and store where directed by owner. Materials that the owner does not want become the property of the contractor to be removed from the site and disposed of properly.

C. Some existing materials are noted to be salvaged for installation at new locations. Disconnect, demount, and remove such equipment along with all related accessories and store on site where directed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify field measurements and circuiting arrangements are as indicated.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents.

D. Report discrepancies to Engineer or Engineer before disturbing existing installation.

E. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings and building to be removed.

B. Coordinate utility service outages with utility company. See additional information in Specification sectoin 26 0500 regarding utility interruptions.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.

E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Notify Owner before partially or completely disabling system.
   2. Notify Owner's monitoring company.
   3. Make notifications at least 96 hours in advance.
   4. Make temporary connections to maintain service in areas adjacent to work area.

F. Existing Telephone System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Notify Owner at least 96 hours before partially or completely disabling system.

G. Existing Fiber Optic Backbone Cabling System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Obtain permission from Owner at least 96 hours before partially or completely disabling system.
   2. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
   1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
   2. PCB- and DEHP-containing lighting ballasts.
   3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.

F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.

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

I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

K. Maintain fire ratings where raceway is to be removed or modified that pass through a fire rated structure, floor, ceiling, wall, etc.

3.04 CLEANING AND REPAIR

A. See Section 01 7419 - Construction Waste Management and Disposal for additional requirements.

B. Clean and repair existing materials and equipment that remain or that are to be reused.

C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION

SECTION 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single conductor building wire.
B. Metal-clad cable.
C. Variable-frequency drive cable.
D. Wiring connectors.
E. Electrical tape.
F. Heat shrink tubing.
G. Oxide inhibiting compound.
H. Wire pulling lubricant.
I. Cable ties.
J. Firestop sleeves.

1.02 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.
B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.
C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).
D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).
E. ASTM B800 - Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes - Annealed and Intermediate Tempers; 2005 (Reapproved 2015).
F. ASTM B801 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy Wire for Subsequent Covering of Insulation; 2016.
G. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.
H. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2013.
I. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
J. NECA 104 - Recommended Practice for Installing Aluminum Building Wire and Cable; 2012.
K. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); 2012.
L. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2009.
M. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
N. NFPA 79 - Electrical Standard for Industrial Machinery; 2021.
O. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.
P. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
Q. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
R. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
S. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
T. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
U. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
V. UL 1479 - Standard for Fire Tests of Through-Penetration Firestops
W. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.
X. UL 2277 - Outline of Investigation for Flexible Motor Supply Cable and Wind Turbine Tray Cable; Current Edition, Including All Revisions.

1.03 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.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.
B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.07 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

2.01 DESCRIPTION OF SYSTEM

A. Conductor and conduit sizes noted are based on type THHN copper unless noted otherwise.
B. 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.
        e. Direct Burial (Outdoors): Direct buried cables are not acceptable.
    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. Cord Drops and Portable Appliance Connections:
        a. Indoors kitchen and similar environments: Type SO, hard service cord.
        b. Indoors shop and similar environments Type STO, thermoplastic, hard service cord.
        c. Outdoors Type STOW-A, thermoplastic, hard service, weather resistant cord.
        d. Include stainless, wire-mesh, strain relief device at terminations to suit applications.
    8. Class 1 Control Circuits: Type THHN-THWN single conductors in raceway.

9. 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.

2.02 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. Nonmetallic-sheathed cable is not permitted.
D. Underground feeder and branch-circuit cable is not permitted.
E. Service entrance cable is not permitted.
F. Armored cable is not permitted.
G. 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. 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.
H. 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. Conductors for Grounding and Bonding: Also comply with Section 26 0526.
    8. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.
    9. Conductor Material:
        a. Provide copper conductors except where aluminum conductors are specifically indicated. Substitution of aluminum conductors for copper is not permitted. Conductor sizes indicated are based on copper unless specifically indicated as aluminum. Conductors designated with the abbreviation "AL" indicate aluminum.
        b. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
        c. Tinned Copper Conductors: Comply with ASTM B33.
        d. Aluminum Conductors (only where specifically indicated or permitted for substitution): AA-8000 series aluminum alloy conductors recognized by ASTM B800 and compact stranded in accordance with ASTM B801 unless otherwise indicated.
    10. 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.

11. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
12. 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) 240Y/120 V, 3 Phase, 4 Wire System:
            (a) Phase A: Black.
            (b) Phase B: Red.
            (c) Phase C: Blue.
            (d) Neutral/Grounded: White.
        4) 240/120 V, 1 Phase, 3 Wire System:
            (a) Phase A: Black.
            (b) Phase B: Red.
            (c) Neutral/Grounded: White.
        5) Equipment Ground, All Systems: Green.
        6) Isolated Ground, All Systems: Green with yellow stripe.
        7) For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.

I. 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.
        1) Size 4 AWG and Larger: Type XHHW-2.
        2) Installed Underground: Type XHHW-2.

b. Aluminum Building Wire (only where specifically indicated or permitted for substitution): Type XHHW-2.

J. 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.

K. 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).

L. 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.
e. Aluminum Conductors: Use compression connectors for all connections.
f. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
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.
7. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

M. ACCESSORIES
1. Electrical Tape:

a. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
b. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
c. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
d. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
e. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.

2. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
3. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
4. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
5. Re-usable / Re-enterable splices.
   a. Equal to Tyco GelCap SL.
   b. Moisture sealant temperature rating -40 degrees C to 105 degrees C.
   c. Clear cap to allow visual inspection.
   d. Two ports accept wires from #14 to #2/0 AWG.
   e. Single port accepts #14 to #6 AWG.
   f. Reenterable.
6. Cable Ties: Material and tensile strength rating suitable for application.
7. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for cables and roofing system to be installed; designed to accommodate existing penetrations where applicable.
8. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

PART 3 EXECUTION

3.01 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.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 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 aluminum conductors in accordance with NECA 104.
E. Install metal-clad cable (Type MC) in accordance with NECA 120.
F. 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.
G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
H. 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.
I. 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.
J. Variable-Frequency Drive Cable: Terminate shielding at both variable-frequency motor controller and associated motor using glands or termination kits recommended by manufacturer.
K. Install conductors with a minimum of 12 inches of slack at each outlet.
L. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.
M. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
N. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
O. 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. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.
    6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
    7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
P. 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.
    1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
        a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
    2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.

a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.

Q. Insulate ends of spare conductors using vinyl insulating electrical tape.

R. 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.

S. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

T. 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.

U. 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

SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 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.
F. Ground access wells.

1.02 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. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. NFPA 780 - Standard for the Installation of Lightning Protection Systems; 2017.
G. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.03 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.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittals procedures.
B. Shop Drawings:
    1. Indicate proposed arrangement for signal reference grids. Include locations of items to be bonded and methods of connection.
C. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.05 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.

1.06 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Existing Work: Existing grounding and bonding system components may be be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
C. 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.
D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
E. 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.

F. 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.
7. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
    a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
    b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.

G. Service-Supplied System Grounding:
1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.

H. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
1. Provide grounding electrode system for each separate building or structure.
2. Provide equipment grounding conductor routed with supply conductors.
3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.

4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

I. Separately Derived System Grounding:
   1. Separately derived systems include, but are not limited to:
      a. Transformers (except autotransformers such as buck-boost transformers).
      b. Generators, when neutral is switched in the transfer switch.
   2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
   3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
   4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.
   5. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
   6. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
   7. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

J. 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.

K. Isolated Ground System:
   1. Where isolated ground receptacles or other isolated ground connections are indicated, provide separate isolated/insulated equipment grounding conductors.
   2. Connect isolated/insulated equipment grounding conductors only to separate isolated/insulated equipment ground busses.
   3. Connect the isolated/insulated equipment grounding conductors to the solidly bonded equipment ground bus only at the service disconnect or separately derived system disconnect. Do not make any other connections between isolated ground system and normal equipment ground system on the load side of this connection.

L. Lightning Protection Systems, in Addition to Requirements of Section 26 4113:
    1. Do not use grounding electrode dedicated for lightning protection system for component of building grounding electrode system provided under this section.
    2. Provide bonding of building grounding electrode system provided under this section and lightning protection grounding electrode system in accordance with NFPA 70 and NFPA 780.
M. Cable Tray Systems: Also comply with Section 26 0536.
N. Pole-Mounted Luminaires: Also comply with Section 26 5600.
O. Static Control Flooring: Provide bonding of static control flooring provided in accordance with Section 09 6500.
P. Static Control Furniture (work benches, etc.): Provide bonding of static control flooring provided in accordance with Manufacturer's instructions and the following:
    1. Provide dedicated #10AWG green insulated copper conductor from ground bus within room or with panelboard service the work surface within minimum 1/2"EMT conduit concealed within walls.

2.02 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 0526:
    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 Bars:
    1. Description: Copper rectangular ground bars with mounting brackets and insulators.
    2. Size: As indicated.
    3. Holes for Connections: As indicated or as required for connections to be made.
E. 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.
F. Ground Access Wells:
    1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
    2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
    3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.
    4. Cover: Factory-identified by permanent means with word "GROUND".

PART 3 EXECUTION

3.01 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.

3.02 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 0553.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Inspect and test in accordance with NETA ATS except Section 4.
C. Perform inspections and tests listed in NETA ATS, Section 7.13.
D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION

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SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
B. Section 05 5000 - Metal Fabrications: Materials and requirements for fabricated metal supports.
C. Section 26 0533.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
D. Section 26 0533.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.
E. Section 26 0548 - Vibration and Seismic Controls for Electrical Systems.
F. Section 26 5100 - Interior Lighting: Additional support and attachment requirements for interior luminaires.
G. Section 26 5600 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
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; 2015.
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.
G. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.04 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 3000.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Include details for fabricated hangers and supports upon request.

1.06 QUALITY ASSURANCE

A. Comply with NFPA 70.
B. Comply with applicable building code.

1.07 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 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. Components for Vibration Isolation and/or Seismic Controls: Comply with Section 26 0548.

C. Materials for Metal Fabricated Supports: Comply with Section 05 5000.

D. 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.

E. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.

F. 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.
2. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.
3. Channel Material:
    a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
    b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
4. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.

G. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
1. Minimum Size, Unless Otherwise Indicated or Required:
    a. Equipment Supports: 1/2 inch diameter.
    b. Busway Supports: 1/2 inch diameter.
    c. Single Conduit up to 1 inch (27 mm) trade size: 1/4 inch diameter.
    d. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter.
    e. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
    f. Outlet Boxes: 1/4 inch diameter.
    g. Luminaires: 1/4 inch diameter.

H. Non-Penetrating Rooftop Supports for Low-Slope Roofs: Steel pedestals with thermoplastic or rubber 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.
1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
2. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
3. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

I. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.

7. Sheet Metal: Use sheet metal screws.
8. Plastic and lead anchors are not permitted.
9. Powder-actuated fasteners are not permitted.
10. Hammer-driven anchors and fasteners are not permitted.
11. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
    a. Comply with MFMA-4.
    b. Channel Material: Use galvanized steel.
    c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

PART 3 EXECUTION

3.01 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.

3.02 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. Provide required vibration isolation and/or seismic controls in accordance with Section 26 0548.
I. 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. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.
    5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
J. Conduit Support and Attachment: Also comply with Section 26 0533.13.
K. Box Support and Attachment: Also comply with Section 26 0533.16.
L. Interior Luminaire Support and Attachment: Also comply with Section 26 5100.
M. Exterior Luminaire Support and Attachment: Also comply with Section 26 5600.
N. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
O. Secure fasteners according to manufacturer's recommended torque settings.
P. Remove temporary supports.
Q. 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.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Inspect support and attachment components for damage and defects.
C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

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

END OF SECTION

SECTION 26 0533.13 - CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).
B. Aluminum rigid metal conduit (RMC).
C. Intermediate metal conduit (IMC).
D. PVC-coated galvanized steel rigid metal conduit (RMC).
E. Flexible metal conduit (FMC).
F. Liquidtight flexible metal conduit (LFMC).
G. Electrical metallic tubing (EMT).
H. Rigid polyvinyl chloride (PVC) conduit.
I. Reinforced thermosetting resin conduit (RTRC).
J. Conduit fittings.
K. Accessories.

1.02 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 C80.5 - American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A); 2015.
D. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.
E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
F. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2013.
G. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.
H. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2012.
I. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2005 (R2013).
J. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2013.
K. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2015.
L. NEMA TC 14 (SERIES) - Reinforced Thermosetting Resin Conduit and Fittings Series; 2015.
M. NEMA TC 14.AG - Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings; 2015.
N. NEMA TC 14.BG - Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings; 2015.
O. NEMA TC 14.XW - Extra Heavy Wall Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings; 2015.
P. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
Q. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
R. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
S. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.
T. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.
U. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
V. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
W. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
X. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.
Y. UL 2420 - Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings; Current Edition, Including All Revisions.
Z. UL 2515 - Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings; Current Edition, Including All Revisions.
AA. UL 2515A - Standard for Supplemental Requirements for Extra Heavy Wall Reinforced Thermosetting Resin Conduit (RTRC) and Fittings; Current Edition, Including All Revisions.

1.03 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.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittals procedures.
B. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.01 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, PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
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. Embedded Within Concrete:
1. Within Slab on Grade (within structural slabs only where approved by Structural Engineer): 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. Within Concrete Walls Above Ground: 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).
3. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from concrete.

E. Concealed Within Masonry Walls: Use electrical metallic tubing (EMT).
F. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).
G. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).
H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.

I. Exposed, Interior, Not Subject to Physical Damage: Use intermediate metal conduit (IMC) or electrical metallic tubing (EMT).
J. 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.
K. Exposed, Exterior: Use intermediate metal conduit (IMC) or PVC-coated galvanized steel rigid metal conduit.
L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit or intermediate metal conduit (IMC).
M. Corrosive Locations Above Ground: Use aluminum rigid metal conduit or reinforced thermosetting resin conduit (RTRC).
N. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
    1. Maximum Length: 6 feet.
O. 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.

2.02 CONDUIT REQUIREMENTS

A. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling a mandrel through them.
B. Electrical Service Conduits: Also comply with Section 26 2100.
C. Communications Systems Conduits: Also comply with Section 27 1000.
D. Fittings for Grounding and Bonding: Also comply with Section 26 0526.
E. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
F. Provide products listed, classified, and labeled as suitable for the purpose intended.
G. 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.
H. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 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.

2.04 ALUMINUM RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.
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 aluminum.
    3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.05 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.

2.06 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.

2.07 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.

2.08 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.

2.09 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.

2.10 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

B. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
   2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.11 REINFORCED THERMOSETTING RESIN CONDUIT (RTRC)

A. Applications:
   1. Above Ground, Not Subject to Physical Damage: Use aboveground (AG), SW (Standard Wall), HW (Heavy Wall), or XW (Extra Heavy Wall) RTRC.
   2. Above Ground, Subject to Physical Damage: Use aboveground (AG), XW (Extra Heavy Wall) RTRC.

3. Underground, Direct-Buried: Use belowground (BG), DB (direct burial) RTRC or aboveground (AG) RTRC.
4. Underground, Embedded in Concrete: Use belowground (BG), EB (encased burial) RTRC, belowground (BG), DB (direct burial) RTRC, or aboveground (AG) RTRC.
5. Do not use RTRC in hazardous (classified) locations.

B. Description: NFPA 70, Type RTRC reinforced thermosetting resin conduit complying with NEMA TC 14 (SERIES).
1. Aboveground (AG) RTRC: Comply with NEMA TC 14.AG and list and label as complying with UL 2515.
2. Aboveground (AG), XW (Extra Heavy Wall) RTRC: Comply with NEMA TC 14.XW and list and label as complying with UL 2515A.
3. Belowground (BG) RTRC: Comply with NEMA TC 14.BG and list and label as complying with UL 2420.

C. Supports: Per manufacturer's recommendations.

D. 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.

2.12 ACCESSORIES

A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil.

B. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.

C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

D. Epoxy Adhesive for RTRC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

E. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.

F. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

G. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.

H. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

PART 3 EXECUTION

3.01 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.

3.02 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 aluminum rigid metal conduit (RMC) in accordance with NECA 102.

E. Install intermediate metal conduit (IMC) in accordance with NECA 101.

F. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.

G. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.

H. 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.

I. 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.

J. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 and Section 26 0529 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 trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use of spring steel conduit clips for support of conduits is not permitted.
9. Use of wire for support of conduits is not permitted.
10. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with the most stringent requirements.

K. 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.

L. 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 8400.

M. Underground Installation:
1. Provide trenching and backfilling in accordance with Section 31 2318.
2. Minimum Cover, Unless Otherwise Indicated or Required:
   a. Underground, Exterior: 24 inches.
   b. Under Slab on Grade: 24 inches to bottom of slab.
3. Provide underground warning tape in accordance with Section 26 0553 along entire conduit length for service entrance where not concrete-encased.

N. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
1. Secure conduits to prevent floating or movement during pouring of concrete.

O. 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 rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
3. Where calculated in accordance with NFPA 70 for reinforced thermosetting resin conduit (RTRC) conduit installed above ground to compensate for thermal expansion and contraction.
4. Where conduits are subject to earth movement by settlement or frost.
5. Any runs over 200 feet.

P. 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.

Q. 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.

R. Provide grounding and bonding in accordance with Section 26 0526.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

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

C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.

D. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 26 0533.16 - BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 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. Boxes and enclosures for integrated power, data, and audio/video.
D. Floor boxes.
E. Underground boxes/enclosures.
F. Accessories.
G. Audio / Video or communication outlet boxes
H. Recessed Backboxes for Monitor Locations.
I. Poke thru box assemblies.

1.02 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; 2012.
D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013.
E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
G. SCTE 77 - Specification for Underground Enclosure Integrity; 2013.
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 508A - Industrial Control Panels; Current Edition, Including All Revisions.
K. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.03 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.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for floor boxes.
    1. Underground Boxes/Enclosures: Include reports for load testing in accordance with SCTE 77 certified by a professional engineer or an independent testing agency upon request.

C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.
D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
    1. See Section 01 6000 - Product Requirements, for additional provisions.
    2. Keys for Lockable Enclosures: Two of each different key.

1.05 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.

1.06 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 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 cast iron boxes or cast aluminum boxes where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
    4. Use cast aluminum boxes where aluminum rigid metal conduit is used.
    5. Use suitable concrete type boxes where flush-mounted in concrete.
    6. Use suitable masonry type boxes where flush-mounted in masonry walls.
    7. Use raised covers suitable for the type of wall construction and device configuration where required.
    8. Use shallow boxes where required by the type of wall construction.
    9. Do not use "through-wall" boxes designed for access from both sides of wall.
    10. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
    11. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
    12. 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.
    13. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
    14. Minimum Box Size, Unless Otherwise Indicated:
        a. Wiring Devices (Other Than Communications Systems Outlets): 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.
        b. Communications Systems Outlets: 4 inch square by 2-1/8 inch (100 by 54 mm) trade size.
    15. Wall Plates: Comply with Section 26 2726.
C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
    1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
    2. NEMA 250 Environment Type, Unless Otherwise Indicated:
        a. Indoor Clean, Dry Locations: Type 1, painted steel.
        b. Outdoor Locations: Type 3R, painted steel unless noted otherwise.
    3. Junction and Pull Boxes Larger Than 100 cubic inches:

a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.

4. Cabinets and Hinged-Cover Enclosures, Other Than Junction and Pull Boxes:
   a. Provide lockable hinged covers, all locks keyed alike unless otherwise indicated.
   b. Back Panels: Painted steel, removable.
5. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.

D. Boxes and Enclosures for Integrated Power, Data, and Audio/Video: Size and configuration as indicated or as required with partitions to separate services; field-connected gangable boxes may be used.

E. Floor Boxes:
1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 2726; 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 unless noted otherwise.
3. Use sheet-steel or cast iron floor boxes within slab above grade.
4. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
5. Manufacturer: Same as manufacturer of floor box service fittings.

F. Underground Boxes/Enclosures:
1. Description: In-ground, open bottom boxes furnished with flush, non-skid covers with legend indicating type of service and stainless steel tamper resistant cover bolts.
2. Size: As indicated on drawings.
3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 12 inches.
4. Applications:
   a. Sidewalks and Landscaped Areas Subject Only to Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77 Tier 8 load rating.
   b. Parking Lots, in Areas Subject Only To Occasional Nondeliberate Vehicular Traffic: Use polymer concrete enclosures, with minimum SCTE 77 Tier 15 load rating.
   c. Do not use polymer concrete enclosures in areas subject to deliberate vehicular traffic.
5. Polymer Concrete Underground Boxes/Enclosures: Comply with SCTE 77.
   a. Manufacturers:
      1) Hubbell Incorporated; Quazite Products: www.hubbellpowersystems.com/#sle.
      2) MacLean Highline: www.macleanhighline.com/#sle.
      3) Oldcastle Precast, Inc: www.oldcastleprecast.com/#sle.
      4) Substitutions: See Section 01 6000 - Product Requirements.
   b. Combination fiberglass/polymer concrete boxes/enclosures are not acceptable. Use all-polymer concrete boxes/enclosures.

G. Audio / Video or communication outlet boxes (up to 2" knockout)
1. Manufacturers
   a. Raco Co.
   b. Subject to complying with these specifications the following manufacturers shall be acceptable.
      1) Thomas and Betts.
      2) Wiremold Co.
      3) Appelton Electric.
      4) Crouse-Hinds.
2. RACO 263
   a. 4-11/16" H x 7-3/4" W x 3-1/4" D
   b. Accepts standard 4" square device and flat covers or RACO 792, 793, 794 3-gang device covers. (2 or 3 gang opening)
   c. Built-in tabs for spanner bars.
   d. Includes 1/2" thru 2" knockouts.
      1) Side: (6) 1/2-3/4 in., (2) 3/4-1 in., (2) 1 - 1-1/4 in., (2) 1-2 in.
      2) Bottom: (2) 1/2-3/4 in., (2) 3/4-1 in., (2) 1 - 1-1/4 in.

e. Accepts 981 voltage partition (UL Listed)
f. Welded construction.
g. Raised ground screw.

3. RACO 260
a. 4-11/16" H x 4-11/16" W x 3-1/4" D
b. Accepts standard 4-11/16" square device and flat covers.
c. Includes 1/2" thru 2" knockouts.
1) Side: (2) 1/2-3/4 in., (2) 3/4-1 in., (2) 1 - 1-1/4 in., (2) 1-2 in.
2) Bottom: (2) 1/2 in., (2) 3/4-1 in.
d. Welded construction.
e. Raised ground screw.

H. Recessed Backboxes for Monitor Locations
1. Manufacturer:
a. Chief Manufacturing.
b. Substitutions subject to compliance with requirements from manufacturers other than those listed above may be included.
2. Description: Recessed, metallic, electrical box, with knockouts and single gang box mounting knockouts:
a. Pre-wire version: Chief PAC526.
b. Include cover kit: Chief PAC526CVRW-KIT.
3. Dimensions: 14-1/4" W x 14-1/4" T x 3.4" deep. Installs between 16" on-center studs.
4. UL listed.
a. Below could likely only be used in a light commercial / residential facility. Note the application materials.

I. 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.

2.02 ACCESSORIES

A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for boxes and facade materials to be installed.

PART 3 EXECUTION

3.01 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.

3.02 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 3100 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 2726.
        b. Communications Systems Outlets: Comply with Section 27 1000.
    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.
    8. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
        a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
        b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
    9. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 0533.13.
    10. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
        a. Concealed above accessible suspended ceilings.
        b. Within joists in areas with no ceiling.
        c. Electrical rooms.
        d. Mechanical equipment rooms.
H. Box Supports:
    1. Secure and support boxes in accordance with NFPA 70 and Section 26 0529 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.
    3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
    4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.
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. Floor-Mounted Cabinets: Mount on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.

L. Install boxes as required to preserve insulation integrity.

M. Metallic Floor Boxes: Install box level at the proper elevation to be flush with finished floor.

N. Underground Boxes/Enclosures:
   1. Install enclosure on gravel base, minimum 6 inches deep.
   2. Flush-mount enclosures located in concrete or paved areas.
   3. Provide cast-in-place concrete collar constructed in accordance with Section 03 3000, minimum 10 inches wide by 12 inches deep, around enclosures that are not located in concrete areas.
   4. Install additional bracing inside enclosures in accordance with manufacturer's instructions to minimize box sidewall deflections during backfilling. Backfill with cover bolted in place.

O. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

P. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

Q. Close unused box openings.

R. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

S. Provide grounding and bonding in accordance with Section 26 0526.

3.03 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 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 0536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal cable tray systems:
   1. Metal ladder cable tray.
   2. Metal wire mesh/basket cable tray.

1.02 REFERENCE STANDARDS

A. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2015.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NEMA VE 1 - Metal Cable Tray Systems; 2017.
D. NEMA VE 2 - Cable Tray Installation Guidelines; 2013, with Errata (2016).
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the arrangement of cable tray with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others. Coordinate the work with other trades to avoid installation of obstructions within cable tray required clearances.
   2. Coordinate arrangement of cable tray with the dimensions and clearance requirements of the actual products to be installed.
   3. Coordinate the work with placement of supports, anchors, etc. required for mounting.
   4. Notify of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
B. Preinstallation Meeting: Convene one week prior to commencing work of this section; require attendance of all affected installers. Review proposed routing, sequence of installation, and protection requirements for installed cable tray.
C. Sequencing:
   1. Do not begin installation of cables until installation of associated cable tray run is complete.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cable tray system components and accessories. Include dimensions, materials, fabrication details, finishes, and span/load ratings.
C. Shop Drawings:
   1. Include dimensioned plan views and sections indicating proposed cable tray routing, required clearances, and locations and details of supports, fittings, building element penetrations, and equipment connections.
   2. Include dimensioned plan views and sections indicating proposed ladder tray routign within communication equipment rooms.
D. Project Record Documents: Record actual routing of cable tray and locations of supports.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and NEMA VE 2, except do not store cable tray outdoors without cover as permitted in NEMA VE 2.
B. Handle products carefully to avoid damage to finish.

PART 2 PRODUCTS

2.01 CABLE TRAY SYSTEM - GENERAL REQUIREMENTS

A. Provide new cable tray system consisting of all required components, fittings, supports, accessories, etc. as necessary for a complete system.
B. Provide products listed, classified, and labeled as suitable for the purpose intended.
C. Do not use cable tray for applications other than as permitted by NFPA 70 and product listing/classification.

D. Provide cable tray system and associated components suitable for use at indicated span/load ratings under the service conditions at the installed location.
E. Unless otherwise indicated, specified span/load ratings are according to NEMA VE 1 (metal cable tray systems) or NEMA FG 1 (fiberglass cable tray systems) with safety factor of 1.5 and working load only (no additional concentrated static load).
F. Unless otherwise indicated, specified load/fill depths and inside widths are nominal values according to NEMA VE 1 (metal cable tray systems) or NEMA FG 1 (fiberglass cable tray systems) with applicable allowable tolerances.

2.02 METAL CABLE TRAY SYSTEMS

A. Manufacturers:
   1. Metal Cable Tray System:
      a. Cablofil, a brand of Legrand North America, Inc: www.legrand.us/cablofil.
      b. Chalfant Manufacturing Company: www.chalfant-obo.com/#sle.
      c. Cope, a brand of Atkore International Inc: www.copecabletray.com.
      d. Thomas & Betts Corporation: www.tnb.com.
      e. Cooper B Line:
   2. Substitutions: See Section 01 6000 - Product Requirements.
B. Comply with NEMA VE 1.
C. Finishes:
   1. Zinc Electroplated Steel: Comply with ASTM B633.
D. Metal Ladder Cable Rack:
   1. Material: Steel, black polyester power paint..
   2. Rung Spacing: 9 inches on center for straight lengths.
   3. Inside Width: 18 inches.
   4. Inside Radius of Fittings: 12 inches.
E. Metal Wire Mesh/Basket Cable Tray:
   1. Material: Zinc electroplated steel or mill-galvanized before fabrication (pre-galvanized) steel.
   2. Tray Depth: As indicated on drawings.
   3. Mesh Spacing: 2 by 4 inches.
   4. Tray Width: As indicated on drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage cable tray system has been completed.
B. Verify that field measurements are as indicated.
C. Verify that the dimensions and span/load ratings of cable tray system components are consistent with the indicated requirements.
D. Verify that mounting surfaces are ready to receive cable tray and associated supports.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install cable tray in accordance with NECA 1 (general workmanship), and NEMA VE 2.
C. Unless otherwise indicated, arrange cable tray to be parallel or perpendicular to building lines.
D. Arrange cable tray to provide required clearances and maintain cable access.
   1. Minimum Clearance Above and Adjacent to Cable Tray: 12 inches.
   2. Cable Tray for Telecommunications Cables: Maintain recommended separation from sources of EMI greater than 5 kVA in accordance with NECA/BICSI 568.
E. Install cable tray plumb and level, with sections aligned and with horizontal runs at the proper elevation.
F. Metal Wire Mesh/Basket Cable Tray: Field fabricate fittings in accordance with manufacturer's instructions, using only manufacturer-approved connectors classified for bonding.
   1. Inside Radius of Fittings: 12 inches.
G. Cable Tray Movement Provisions:
   1. Provide suitable expansion fittings where cable tray is subject to movement, including but not limited to:

a. Where cable tray crosses structural joints intended for expansion.
b. Long straight cable tray runs in accordance with NEMA VE 2.

2. Use expansion guides in lieu of hold-down clamps where prescribed in NEMA VE 2.
3. Set gaps for expansion fittings in accordance with NEMA VE 2.

H. Cable Provisions:
1. Use suitable fixed barrier strips to maintain separation of cables as indicated and as required by NFPA 70.
2. Use suitable drop-out fittings or bushings where cables exit cable tray as required to maintain minimum cable bending radius.
3. Use suitable cable support fittings for long vertical cable tray runs with heavy cables.

I. Provide end closures at unconnected ends of cable tray runs.

J. Cable Tray Support:
1. Use manufacturer's recommended hangers and supports, located in accordance with NEMA VE 2 and manufacturer's requirements, but not exceeding specified span unless otherwise approved by Engineer. Provide required support and attachment in accordance with Section 26 0529, where not furnished by cable tray manufacturer.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

K. Grounding and Bonding Requirements, in Addition to Requirements of Section 26 0526:
1. Comply with grounding and bonding requirements of NEMA VE 2.
2. Ground and bond metal cable tray in accordance with NFPA 70, National Electrical Code, Article 392: Cable Trays.
3. Metal Cable Tray Systems: Use suitable bonding jumpers or classified connectors to provide electrical continuity.
4. Painted Cable Tray Systems: Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
5. Metal cable tray system may be used as sole equipment grounding conductor only where all conditional requirements of NFPA 70 are met, including but not limited to:
a. Installation must be in a qualifying facility with suitable maintenance and supervision as determined by authorities having jurisdiction.
b. Cable tray system must be steel or aluminum (as specified) and classified as an equipment grounding conductor (note that stainless steel cable tray is not permitted for use as an equipment grounding conductor).
c. Cable tray must meet minimum cross-sectional area requirements.

L. Cable Installation:
1. Comply with cable installation requirements of NEMA VE 2.
2. Use appropriate cable pulling tools, applied to prevent excessive force on cable tray system and maintain minimum cable bending radius.
3. Use cable clamps or cable ties to fasten conductors/cables to vertical and horizontal runs of cable tray.
a. Distance Between Fastening Points for Vertical Runs: 18 inches.
b. Distance Between Fastening Points for Horizontal Runs: As required to maintain spacing and confine conductor/cable within the cable fill area.

M. Penetrations: Install firestopping to preserve fire resistance rating of building elements, using materials and methods specified in Section 07 8400.

N. Identification Requirements, in Addition to Those Specified in Section 26 0553.
1. Use warning labels to identify cable tray with the word message "WARNING! Do Not Use As A Walkway, Ladder, Or Support For Personnel. Use Only As A Mechanical Support For Cables, Tubing and Raceways." at maximum intervals of 20 feet.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Inspect cable tray system for damage and defects.

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

D. Correct deficiencies and replace damaged or defective cable tray system components.

3.04 ADJUSTING

A. Adjust tightness of mechanical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Remove dirt and debris from cable tray.

B. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

SECTION 26 0548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 DEFINITIONS

A. Electrical Component: Where referenced in this section in regards to seismic controls, applies to any portion of the electrical system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g., conduit, cable tray).

1.03 REFERENCE STANDARDS

A. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; Most Recent Edition Cited by Referring Code or Reference Standard.
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.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
    1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment 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. 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 3000.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
    1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.
C. Shop Drawings - Vibration Isolation Systems:
    1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators; indicate equipment weights and static deflections.
    2. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable; indicate equipment mounting provisions.

1.06 QUALITY ASSURANCE

A. Comply with NFPA 70.
B. Comply with applicable building code.

1.07 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 VIBRATION ISOLATION REQUIREMENTS

A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing electrical equipment and/or electrical connections to vibration-isolated equipment.
B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:

C. General Requirements:
    1. Select vibration isolators to provide required static deflection.
    2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.
D. Equipment Isolation:
    1. Transformers:
        a. Specified vibration isolators are in addition to any factory-installed internal core and coil assembly vibration isolators unless otherwise indicated.
        b. Floor-Mounted Transformers, Nonseismic Applications: Use resilient material isolator pads, resilient material isolator mounts, or open (unhoused) spring isolators.
        c. Suspended Transformers, Nonseismic Applications: Use resilient material isolator hangers, spring isolator hangers, or combination resilient material/spring isolator hangers.
        d. Wall-Mounted Transformers, Nonseismic Applications: Use resilient material isolator mounts.
        e. Minimum Static Deflection:
            1) Transformers Mounted on Grade-Level Slabs: 0.25 inch deflection unless otherwise indicated.
            2) Transformers Mounted at Above-Grade Levels: 0.5 inch deflection unless otherwise indicated.
    2. Engine Generators:
        a. Specified vibration isolators are in addition to any factory-installed internal vibration isolators between generator set and integral base unless otherwise indicated; obtain generator set manufacturer approval of applied vibration isolation.
        b. Nonseismic Applications, Isolators Not Located Below Sub-Base Fuel Tank: Use housed spring isolators or restrained spring isolators.
        c. Nonseismic Applications, Isolators Located Below Sub-Base Fuel Tank: Use restrained spring isolators.
        d. Minimum Static Deflection:
            1) Generators Mounted on Grade-Level Slabs: 1 inch deflection unless otherwise indicated.
E. Conduit Isolation:
    1. Use flexible conduit or cable for electrical connections to vibration-isolated equipment, including equipment installed under other sections or by others.

2.02 VIBRATION ISOLATORS

A. General Requirements:
    1. Resilient Materials for Vibration Isolators: Oil, ozone, and oxidant resistant.
    2. Spring Elements for Spring Isolators:
        a. Color code or otherwise identify springs to indicate load capacity.
        b. Lateral Stability: Minimum lateral stiffness to vertical stiffness ratio of 0.8.
        c. Designed to operate in the linear portion of their load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
        d. Designed to provide additional travel to solid of not less than 50 percent of rated deflection at rated load.
        e. Selected to provide designed deflection of not less than 75 percent of specified deflection.
        f. Selected to function without undue stress or overloading.
B. Vibration Isolators for Nonseismic Applications:
    1. Resilient Material Isolator Pads:
        a. Description: Single or multiple layer pads utilizing elastomeric (e.g., neoprene, rubber) or fiberglass isolator material.
        b. Pad Thickness: As required for specified minimum static deflection; minimum 0.25 inch thickness.
        c. Multiple Layer Pads: Provide bonded, galvanized sheet metal separation plate between each layer.
    2. Resilient Material Isolator Mounts, Nonseismic:

a. Description: Mounting assemblies for bolting equipment to supporting structure utilizing elastomeric (e.g., neoprene, rubber) or fiberglass isolator material; fail-safe type.

3. Open (Unhoused) Spring Isolators:
   a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) without a housing.
   b. Bottom Load Plate: Nonskid, molded, elastomeric isolator material or steel with nonskid elastomeric isolator pad with provisions for bolting to supporting structure as required.
   c. Furnished with integral leveling device for positioning and securing supported equipment.
4. Housed Spring Isolators:
   a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing.
   b. Furnished with integral elastomeric snubbing elements, nonadjustable type, for limiting equipment movement and preventing metal-to-metal contact between housing elements.
   c. Bottom Load Plate: Steel with nonskid, elastomeric isolator pad with provisions for bolting to supporting structure as required.
   d. Furnished with integral leveling device for positioning and securing supported equipment.
5. Restrained Spring Isolators, Nonseismic:
   a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing designed to prevent movement of supported equipment above an adjustable vertical limit stop.
   b. Bottom Load Plate: Steel with nonskid, elastomeric isolator pad with provisions for bolting to supporting structure as required.
   c. Furnished with integral leveling device for positioning and securing supported equipment.
   d. Provides constant free and operating height.
6. Resilient Material Isolator Hangers, Nonseismic:
   a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing elastomeric (e.g., neoprene, rubber) or fiberglass isolator material for the lower hanger rod connection.
7. Spring Isolator Hangers, Nonseismic:
   a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) in series with an elastomeric element for the lower hanger rod connection.
   b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.
8. Combination Resilient Material/Spring Isolator Hangers, Nonseismic:
   a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) for the lower hanger rod connection and elastomeric (e.g., neoprene, rubber) or fiberglass isolator material for the upper hanger rod connection.
   b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.
B. Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install products in accordance with applicable requirements of NECA 1 (general workmanship).

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
D. Secure fasteners according to manufacturer's recommended torque settings.
E. Install flexible conduit and cable connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.
F. Vibration Isolation Systems:
    1. Spring Isolators:
        a. Position equipment at operating height; provide temporary blocking as required.
        b. Lift equipment free of isolators prior to lateral repositioning to avoid damage to isolators.
        c. Level equipment by adjusting isolators gradually in sequence to raise equipment uniformly such that excessive weight or stress is not placed on any single isolator.
    2. Isolator Hangers:
        a. Use precompressed isolator hangers where required to facilitate installation and prevent damage to equipment utility connection provisions.
        b. Locate isolator hangers at top of hanger rods in accordance with manufacturer's instructions.
    3. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
    4. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
    5. Adjust isolators to be free of isolation short circuits during normal operation.
    6. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Inspect vibration isolation and/or seismic control components for damage and defects.
C. Vibration Isolation Systems:
    1. Verify isolator static deflections.
    2. Verify vibration isolation performance during normal operation; investigate sources of isolation short circuits.
D. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.

END OF SECTION

SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification requirements.
B. Identification nameplates and labels.
C. Wire and cable markers.
D. Voltage markers.
E. Underground warning tape.
F. Floor marking tape.
G. Warning signs and labels.

1.02 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. NFPA 70E - Standard for Electrical Safety in the Workplace; 2015.
E. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.03 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.

1.04 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.05 FIELD CONDITIONS

A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
B. 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 main overcurrent protective device.
            5) 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) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.

5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil. Where room names/numbers are referenced, use the most up-to-date architectural drawings and schedules as a reference, not engineering plans.
6) 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.

e. Busway:
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) Provide identification at maximum intervals of 40 feet.
5) Use identification nameplate to identify load(s) served for each plug-in unit. Include location when not within sight of equipment.

f. Enclosed Contactors:
1) Identify ampere rating.
2) Identify voltage and phase.
3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
4) Identify coil voltage.
5) Identify load(s) and associated circuits controlled. Include location.

g. Transfer Switches:
1) Identify voltage and phase.
2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
3) Identify load(s) served. Include location when not within sight of equipment.
4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.

h. Electricity Meters:
1) Identify load(s) metered.

2. Service Equipment:
a. Use identification nameplate to identify each service disconnecting means.
b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.

3. Emergency System Equipment:
a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.

c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.

4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
5. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.
6. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
7. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
8. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
9. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.
   a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches wide, painted in accordance with Section 09 9123 and 09 9113.
10. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations indicated.
11. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
    a. Minimum Size: 3.5 by 5 inches.
    b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.
    c. Service Equipment: Include the following information in accordance with NFPA 70.
       1) Nominal system voltage.
       2) Available fault current.
       3) Clearing time of service overcurrent protective device(s).
       4) Date label applied.

C. Identification for Conductors and Cables:
   1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.
   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.
   3. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.

D. Identification for Raceways:
   1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
   2. Use printed labels to identify conduits of new and existing fire alarm, power, and communications systems for accessible conduits at maximum intervals of 20 feet.
      a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
         1) Color Code:
            (a) Fire Alarm System: Red.
            (b) Communication System: Blue.
         2) Field-Painting: Comply with Section 09 9123 and 09 9113.
         3) Vinyl Color Coding Electrical Tape: Comply with Section 26 0519.

3. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
4. Use underground warning tape to identify underground raceways.

E. Identification for Cable Tray: Comply with Section 26 0536.

F. Identification for Boxes:
1. Use voltage markers or color coded boxes to identify systems other than normal power system.
a. Color-Coded Boxes: Field-painted in accordance with Section 09 9123 and 09 9113 per the same color code used for raceways.
1) Emergency power branch: Red.
2) Fire Alarm System: Red.
3) Communication System: Blue.
b. For exposed boxes in public areas, do not color code.
2. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.

G. Identification for Devices:
1. Identification for Communications Devices: Comply with Section 27 1000.
2. Wiring Device and Wallplate Finishes: Comply with Section 26 2726.
3. Use identification label to identify fire alarm system devices.
a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.
4. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
5. 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.
6. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

H. Identification for Luminaires:
1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

2.02 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.

2.03 WIRE AND CABLE MARKERS

A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
C. Legend: Power source and circuit number or other designation indicated.
D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
E. Minimum Text Height: 1/8 inch.
F. Color: Black text on white background unless otherwise indicated.

2.04 VOLTAGE MARKERS

A. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
C. Minimum Size:
   1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
   2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
   3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
   4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
D. Legend:
   1. Markers for Voltage Identification: Highest voltage present.
   2. Markers for System Identification:
      a. Emergency Power System: Text "EMERGENCY".
E. Color: Black text on orange background unless otherwise indicated.

2.05 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:
   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.

2.06 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).

2.07 FLOOR MARKING TAPE

A. Floor Marking Tape for Equipment Working Clearance Identification: Self-adhesive vinyl or polyester tape with overlaminate, 3 inches wide, with alternating black and white stripes.

2.08 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

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 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. Conduits: Legible from the floor.
8. Boxes: Outside face of cover.
9. Conductors and Cables: Legible from the point of access.
10. 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.

END OF SECTION

SECTION 26 0560 - UNDERGROUND WORK FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Excavation, trenching, and backfilling for underground electrical work including:
   1. Underground duct.
   2. Handholes.

1.02 RELATED DOCUMENTS

A. Section 31 23 17 Site Excavation.
B. Section 31 23 18 Site Trenching.
C. Section 31 23 24 Site Fill.

1.03 REFERENCES

A. General References:
   1. ANSI/IEEE C2 - National Electrical Safety Code.
   2. ANSI/NFPA 70 - National Electrical Code.
B. Underground Ducts:
   1. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
   2. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
   3. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
   4. NEMA TC 6 - PVC and ABS Plastic Utilities Duct for Underground Installation.
   5. NEMA TC 7 - Smooth-Wall Coilable Electrical Polyethylene Conduit
   6. NEMA TC 8 - Extra-Strength PVC Plastic Utilities Duct for Underground Installation.
   7. NEMA TC 9 - Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.
   8. NEMA TC 10 - PVC and ABS Plastic Communications Duct and Fittings for Underground Installation.
   9. UL 651 Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

1.04 DEFINITIONS

A. The following definitions apply to excavation operations:
   1. Excavation: Refers to hand digging, trenching, back hoeing or any other method of moving existing site material from one place to another or removing existing site material from the site.
   2. Additional Excavation: Refers to excavation required to reach suitable bearing materials if unsuitable bearing materials are encountered at planned sub-grade elevation. Contract sum may be adjusted by an appropriate Contract Modification.
   3. Subbase: Refers to compacted soil layer used in pavement systems between the sub-grade and the pavement base course material.
   4. Sub-grade: Refers to the compacted soil immediately below the slab or pavement system.
   5. Unauthorized Excavation: Consists of removal of materials beyond indicated sub-grade elevations or dimensions without specific direction from the Engineer.
   6. Subsurface Utilities: Refers to all privately and publicly owned lines such as water, sewer, sprinkler, electric, telephone, data, cable TV, gas, heating fuel, vent, motor fuel, signal, alarm, communications and any other line, pipe, cable or wire.

1.05 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
B. Furnish products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

1.06 SUBMITTALS

A. Submit according to the requirements of Division 01 and Section - Electrical General Requirements.
B. Submittal shall include the following:
   1. Manufacturer's product data for hand holes (hand holes specified in Section "Raceways and Boxes for Electrical Systems"), innerduct, and boreable raceway system.
   2. Shop drawings for hand holes.
C. As-Built Drawings: Record route, locations, and depths of underground electrical work.

PART 2 PRODUCTS

2.01 SOIL MATERIALS

A. See section 31 23 18 Trenching and 31 23 24 Site Fill.

2.02 UNDERGROUND RACEWAY

A. Power and Communications Circuit Plastic Raceway:
   1. Description: Comply with UL 651 and NEMA TC 2; Schedule 40 or 80 PVC as indicated. Schedule 40 typically, schedule 80 under pavement.
   2. Fittings and Conduit Bodies: NEMA TC 3.

2.03 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:
   1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
   2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   3. Retain one or more of six paragraphs below to select enclosure type(s) for areas not subject to traffic by vehicles. Indicate location of each type in "Raceway Application" Article. For enclosures with cover options, verify that selected cover is available with load rating specified in "Raceway Application" Article. If retaining more than one type of box and cover combination, indicate location of each type on Drawings.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of a dry mix of gravel, sand and bounded with polyester resin, and reinforced with fiberglass cloth.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Oldcastle Enclosure Solutions; H-Series Products or comparable product by one of the following:
      a. Armorcast Products Company.
      b. Highline.
      c. NewBasis.
      d. Quazite: Hubbell Power System, Inc.
   2. Standard: Comply with ANSI/SCTE 77, Telecordia GR-902, ASTM C 857, WUC Guide 3.6.
   3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
      a. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
      b. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
      c. Cover Legend: Molded lettering, "ELECTRIC" or other custom logos and lettering.
   4. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   5. Handholes 11 Inches Wide by 18 Inches Long.

2.04 ACCESSORIES

A. Underground Warning Tape: 4 inch wide plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that excavation, base material installation, and compaction is completed.
B. Verify that field measurements are as shown on drawings.
C. Subsurface utilities were investigated during the design of the Project. The locations of existing subsurface utilities are approximately indicated and have not been independently verified.
D. In addition to his own investigations, the Contractor shall call the following marking services prior to digging for any underground work:
   1. North Dakota 1-800-795-0555 (Location alert)

3.02 PREPARATION

A. Prepare excavation in accordance with manhole manufacturer's instruction.
B. Coordinate work with project conditions.

C. Verify routing and termination locations of duct bank prior to excavation for rough-in.
D. Verify locations of manholes prior to excavating for installation.
E. Duct bank routing is shown in approximate locations unless dimensions are indicated. Route as required to complete duct system.
F. Manhole locations are shown in approximate locations unless dimensions are indicated. Locate as required to complete ductbank system.
G. Install work in locations shown on drawings, unless prevented by Project conditions.
H. Coordinate connection of interior electrical systems with exterior underground and overhead utilities. Comply with requirements of franchised service companies.
I. Prepare drawings showing proposed rearrangement of work to meet Project conditions, including changes to work specified in other Divisions. Obtain permission of Engineer before proceeding.

3.03 EXCAVATION

A. Slope sides of excavations to comply with codes and ordinances. Shore and brace as required for stability of excavation.
B. Install sediment and erosion control measures in accordance with codes and ordinances.
C. Material Storage:
    1. Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
    2. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
    3. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
D. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
E. Trenching: Excavate trenches for electrical installations as follows:
    1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and minimum of 6 to 9 inches clearance on both sides of raceways and equipment.
    2. Excavate trenches to depth indicated or required.
    3. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.
F. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide a minimum of 6 inches of sand cushion between rock bearing surface and electrical installations.
G. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.
H. Backfilling and Filling: as directed in section 31 23 18 Site Trenching.
I. Placement and Compaction: as directed in section 31 23 18 Site Trenching.

3.04 FIELD QUALITY CONTROL

A. The Contractor shall determine the exact location of all utilities before commencing work and agrees to be fully responsible for any and all damages which might occur do to failure to exactly locate any and all underground utilities. If any uncharted of incorrectly chartered subsurface utilities are encountered, contact Utility owner immediately for instructions.
B. Support and protect utilities indicated to remain (or not indicated to be removed) during excavation operations.
C. Maintain and protect existing building services that transit the area affected by selective demolition.
D. Protect structures, subsurface and surface utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
E. Remove existing subsurface utilities indicated to be removed.
F. Use of explosives is not permitted.

END OF SECTION

SECTION 26 0573 - POWER SYSTEM STUDIES

PART 1 GENERAL

1.01 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.

1.02 RELATED REQUIREMENTS

A. Section 26 0553 - Identification for Electrical Systems: Additional requirements for arc flash hazard warning labels.
B. Section 26 2100 - Low-Voltage Electrical Service Entrance.
    1. Includes Utility Company contact information.

1.03 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 (Reaffirmed 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 - Includes 1584, 1584A and 1584B; 2002 (Amended 2011).
G. NEMA MG 1 - Motors and Generators; 2017.
H. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
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.

1.04 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. Pre-Study Meeting: Conduct meeting with Engineer to discuss system operating modes and conditions to be considered in studies.
C. 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.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Study reports, stamped or sealed and signed by study preparer.
C. Product Data: In addition to submittal requirements specified in other sections, include manufacturer's standard catalog pages and data sheets for equipment and protective devices indicating information relevant to studies.
    1. Include impedance data for engine generators.
    2. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
    3. Include documentation of listed series ratings upon request.
    4. Identify modifications made in accordance with studies that:

a. Can be made at no additional cost to Owner.
b. As submitted will involve a change to the contract sum.

D. Arc Flash Hazard Warning Label Samples: One of each type and legend specified.
E. Site-specific arc flash hazard warning labels.
F. Field quality control reports.
G. Certification that field adjustable protective devices have been set in accordance with requirements of studies.
H. Project Record Documents: Revise studies as required to reflect as-built conditions.
1. Include hard copies with operation and maintenance data submittals.
2. Include computer software files used to prepare studies with file name(s) cross-referenced to specific pieces of equipment and systems.

1.06 POWER SYSTEM STUDIES

A. Scope of Studies:
1. Perform analysis of both new and directly affected existing portions of electrical distribution system as indicated on drawings.
2. 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).
3. Include in analysis alternate sources and operating modes (including known future configurations) to determine worst case conditions.
a. Known Operating Modes:
1) Utility as source.
2) Generator as source.
3) Maintenance settings.

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: See Section 26 2100 for Utility Company contact information.
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 1 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.
2. Existing Installations:

a. Collect data on existing electrical distribution system necessary for completion of studies, including field verification of available existing data (e.g. construction documents, previous studies). Include actual settings for field-adjustable devices.

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).
   3. Analyze protective devices and associated settings for suitable margins between time-current curves to achieve full selective coordination for the essential electrical distribution branches and best possible protection for the normal and optional stand-by distribution branches while providing adequate protection for equipment and conductors.

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.

1.07 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.
    1. Study preparer may be employed by the manufacturer of the electrical distribution equipment.
    2. Study preparer may be employed by field testing agency.

B. Computer Software for Study Preparation: Use the latest edition of commercially available software utilizing specified methodologies.
    1. Acceptable Software Products:
        a. EasyPower LLC: www.easypower.com/#sle.
        b. SKM Systems Analysis, Inc: www.skm.com/#sle.
        c. Substitutions: See Section 01 6000 - Product Requirements.

PART 2 PRODUCTS

2.01 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 0553.
    2. Minimum Size: 4 by 6 inches.
    3. 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 orange header that reads "WARNING" unless otherwise indicated.

b. Include the text "Arc Flash and Shock Hazard; Appropriate PPE Required" or approved equivalent.
c. 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

3.01 INSTALLATION

A. Install arc flash warning labels in accordance with Section 26 0553.

3.02 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Provide the services of field testing agency or equipment manufacturer's representative to perform inspection, testing, and adjusting.
C. Inspect and test in accordance with NETA ATS, except Section 4.
D. Adjust equipment and protective devices for compliance with studies and recommended settings.
E. Notify Engineer of any conflicts with or deviations from studies. Obtain direction before proceeding.
F. Submit detailed reports indicating inspection and testing results, and final adjusted settings.

3.03 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
B. See Section 01 7900 - Demonstration and Training, for additional requirements.

END OF SECTION

SECTION 26 0583 - WIRING CONNECTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General electrical connections to equipment.
B. Elevators.
C. Owner furnished tools and equipment.

1.02 REFERENCE STANDARDS

A. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (R2015).
B. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2016.
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
    1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
    2. Determine connection locations and requirements.
B. Sequencing:
    1. Install rough-in of electrical connections before installation of equipment is required.
    2. Make electrical connections before required start-up of equipment.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. As built drawings: mark as-built drawings with final connection configurations (cord and plug, direct, etc.), final equipment locations, and final circuit configurations.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.
B. Products: Listed, classified, and labeled as suitable for the purpose intended.
C. 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

2.01 MATERIALS

A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
    1. Colors: Comply with NEMA WD 1.
    2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
    3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
B. Disconnect Switches: As specified in Section 26 2816.16 and in individual equipment sections.
C. Wiring Devices: As specified in Section 26 2726.
D. Conduit: As specified in Section 26 0533.13.
E. Wire and Cable: As specified in Section 26 0519.
F. Boxes: As specified in Section 26 0533.16.

2.02 EQUIPMENT CONNECTIONS

A. See equipment schedules on Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.
B. Examine existing equipment noted to be relocated to verify:
    1. Receptacle configurations.
    2. Connection points, sizes, and configurations.
C. Examine existing equipment noted to be relocated to determine condition of existing electrical apparatus.

3.02 GENRAL ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.

B. Provide all necessary boxes, raceways, and wiring required to make equipment and systems complete and operable.
C. Install disconnect switches, controllers, control stations, and control devices provided with equipment to complete equipment wiring requirements unless noted otherwise.
    1. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings.
D. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components.
    1. Connect equipment for ease of disconnecting, with minimum of interference with other installations
E. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
F. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
G. Provide receptacle outlet to accommodate connection with attachment plug where equipment is prvided with an attachment plug.
H. Provide cord and cap where field-supplied attachment plug is required.
I. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
J. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
K. Install terminal block jumpers to complete equipment wiring requirements.
L. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

3.03 OWNER FURNISHED TOOLS AND EQUIPMENT

A. Preparation
    1. Obtain equipment product data sheets, catalog sheets or similar for all new purchased owner equipment and compare manufacturer's data with outlets specified, shown, or indicated in the Construction Documents. Submit any discrepencies for clarification via Request for Information.
    2. For all existing equipment to be installed, obtain equipment product sheets, catalog sheets, or similar or perform field survey to compare manufacturer's data with outlets specified, shown, or indicated in the Construction Documents. Submit any discrepencies for clarification via Request for Information.
B. Make electrical connections in accordance with equipment manufacturer's instructions.
C. Provide all necessary boxes, raceways, and wiring required to make equipment and systems complete and operable.
D. Install disconnect switches, controllers, control stations, and control devices provided with equipment to complete equipment wiring requirements unless noted otherwise.
    1. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings.
E. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components.
    1. Connect equipment for ease of disconnecting, with minimum of interference with other installations
F. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
G. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
H. Provide receptacle outlet to accommodate connection with attachment plug where equipment is prvided with an attachment plug.
I. Provide cord and cap where field-supplied attachment plug is required.
J. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
K. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
L. Install terminal block jumpers to complete equipment wiring requirements.

M. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

3.04 ELEVATOR CONNECTIONS

A. Provide a dedicated telephone line from the demarcation point to the elevator controller. This line shall not share a connection with "general use" lines of fax machines or voice connections. Advise the Owner of the need to order these telephone lines with their telephone service.

B. Provide a panel (no door) in the Elevator Machine Room with separate 120 volt circuit breakers to the following items. Source of power to this panel shall be the emergency distribution system branch when such exist
   1. Car light and fan (15 Amp).
   2. Light and GFI Receptacle(s) in Elevator Machine Room (20 Amp).
   3. Elevator shaft damper (where present) (20 Amp).

C. Provide outlet box in Machine Room for telephone cable to car telephone outlet.

D. Provide conduit and wire for car light/fan and conduit for telephone to elevator controller for connection to the traveling cable assembly by the elevator installer.

E. Receptacles
   1. Provide GFCI receptacle in elevator pit.
   2. Provdie GFCI receptcle adjacent to elevator equipment located in elevator shaft.

F. Lighting
   1. Provide light in elevator pit.
   2. Provide light above elevator equipment located within elevator shaft.
   3. Provide light at top of elevator shaft.
   4. Provide light switch at elevator pit adjacent to ladder and adjacent to elevator equipment located in shaft.
   5. Locate fixtures as directed by elevator installer.

G. Fire Alarm Interfaces
   1. Where elevator shaft is sprinkled:
      a. Provide addressable fire alarm control relay and addressable fire alarm monitor relay to operate shunt trip elevator disconnect and monitor shunt trip status and shunt trip voltage. Fire alarm system shall operate shunt trip upon water flow in sprinkler system or operation of heat detectors or smoke detector in elevator shaft and / or machine rooms.
      b. Provide fixed temperature heat detector within 2' of shaft sprinkler heads in the elevator shaft and / or machine room. Temperature rating of heat detector shall be less than rating of sprinkler head.
   2. Provide smoke detector at each elevator landing.
   3. Provide smoke detector at top of elevator shaft.
   4. Provide addressable fire alarm relay for primary and secondary floor recall. System must insure elevator lockout at the Main Floor unless Main Floor unit has alarmed. In such case of Main Floor alarm, lockout will occur at the next available non-alarmed floor.

H. Where elevator shaft damper is provided, provide a flush tumbler type key switch and pilot light at the Main Floor Lobby to control a motorized damper at the top of the elevator shaft. Pilot light shall indicate when damper is open.

END OF SECTION

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SECTION 26 0813 - TESTING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes general requirements that pertain to all Performance Verification Testing and Acceptance Testing requirements listed in Division 26, 27, and 28 specifications.

B. See Part 3 paragraph titled "Field Quality Control" of individual specification sections of Division 26, 27, and 28 for test methods, procedures, test values, etc. specific to the materials and labor specified in that section.

1.02 DEFINITIONS

A. See Section 26 0000 for definition of performance verification testing and acceptance testing.

1.03 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.

1.04 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. Division of Responsibility for Performance Verification Testing:
   1. The Contractor shall provide performance verification testing.
   2. All required documentation shall be provided by the Contractor including contract documents, specifications, equipment submittal data (e.g. shop drawings).
   3. Contractor shall provide a short-circuit analysis, a coordination study, and a protective device setting sheet.
   4. Contractor shall provide notification to the Architect of test dates and times.

E. Division of Responsibility for Acceptance Testing:
   1. As noted in NETA Acceptance Testing Specifications section 4 with modifications noted below.
   2. 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.
   3. The Contractor shall provide the following:
      a. A short-circuit analysis, a coordination study, and a protective device setting sheet.
      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.

1.05 QUALITY ASSURANCE

A. Provide testing in accordance with NETA Acceptance Testing Specifications section 3 with modifications.
B. 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.

1.06 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.

1.07 SUBMITTALS

A. Operation and Maintenance Manuals: All test reports and / or certificates shall be included with the O & M Manuals.

PART 2 PRODUCTS

2.01 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.

2.02 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.

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PART 3 EXECUTION

3.01 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.

3.02 EXECUTION

A. Perform tests noted herein and specified elsewhere in Division 26, 27, and 28 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.

3.03 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

SECTION 26 0923 - LIGHTING CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Occupancy sensors
B. Manual control components
C. Touchscreens
D. Network lighting control processors
E. Daylighting controls
F. Accessories

1.02 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
B. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; 2000 (R2010).
C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 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.

1.04 SUBMITTALS

A. See Section 01 3000 - 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.

1.05 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 6000 - 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. 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.

1.06 SPARE MATERIALS

A. Provide two (2) additional of each lighting control device for spares to be used over the course of construction.
B. Turn all unused spare materials over to owner as Maintenance Materials at closeout.

1.07 QUALITY ASSURANCE

A. Designer Qualifications: Perform design under direct supervision of Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.
C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
D. Documents at Project Site: Maintain at project site one copy of manufacturer's instructions, erection drawings, and shop drawings.

1.08 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 7419 - 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.

1.09 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY

A. See Section 01 7800 - 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

2.01 DESCRIPTION OF LIGHTING CONTROLS

A. Provide a full lighting control system. General system types to be used on this project are:
   1. Basic Manual Lighting controls: lighting controls designed for manual-only control of individual spaces in buildings.
   2. Standalone automatic lighting controls:low-voltage automatic lighting controls designed for economical control of individual spaces.
   3. 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.
   4. Wireless lighting controls are not allowed.

2.02 MANUFACTURERS

A. Acuity Brands Lighting:
   1. SensorSwitch
   2. nLight
B. Leviton:
   1. GreenMAX DRC
C. Legrand Wattstopper DLM
D. Cooper Controls:
   1. WaveLinx CAT
E. Lutron Electronics:
   1. Quantum

2.03 LOW-TEMPERATURE / HIGH-HUMIDITY COMPONENTS

A. Where indicated on drawings, provide components with electronics coated for corrosion resistance and operable down to -40°F/-40°C.

2.04 MANUAL CONTROL COMPONENTS

A. Single Pole Single Throw (SPST) Switches: refer to Section 26 2726.

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 2726, unless otherwise indicated.
   2. Control Type:
      a. Basic: Decorator rocker control type with preset slide adjustment.
      b. Standalone: Digital fade type with tap on/off, dimming, and preset scene control where indicated. Laser-engraved legends. Unmarked buttons are not acceptable.
      c. 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.

C. Digital Switches
   1. Finish: Match finishes specified for wiring devices in Section 26 2726, unless otherwise indicated.
   2. Control: Digital fade type with separated tap on/off. Laser-engraved legends. Unmarked buttons are not acceptable.

D. Touchscreens
   1. Description: wall-mounted glass lighting control touchscreen panels from the same manufacturer of other lighting controls used on this project.
   2. Glass capactive touch-type; resistive-touch panels are not allowed unless specifically approved for use.
   3. Capable of integrating into new or existing lighting control networks.
   4. Capable of implementing a user-defined security lockout code.
   5. Interface: Installer and user-programmable with customizable pages that may include individual zone switching and dimming control, scene selection and programming, and RGB control via a digital color wheel; where applicable.
   6. All security settings, scenes, and pages are to be coordinated with the user during programming.

2.05 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. Standalone low-voltage sensors: low voltage units, for use with separate compatible accessory power packs or fixtures with integrated control modules.
      b. Network-connected sensors: low-voltage, individually-addressable units for use with separate network-controlled accessory power packs or networked luminaires with integrated conrol modules.
   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. Furnish sensors with a set of contacts for connection to mechanical control systems, when these contacts are not provided by other components within each area.
11. 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.
12. Load Rating for Line Voltage Occupancy Sensors: As required to control the load indicated on drawings.
13. Load Rating for Line Voltage Occupancy Sensors:
    a. Motor Load: Not less than 1/6 HP.

B. Wall Switch/Dimmer Occupancy Sensors
1. Description: Decorator-style occupancy sensors designed for installation in standard single-gang wall box at standard wall switch mounting height with a field of view of 180 degrees, integral manual controls, and no leakage current to load in off mode.
2. Provide vandal resistant lenses for wall switch occupancy sensors where indicated.
3. 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.

D. Directional Occupancy Sensors:
1. Designed for wall or ceiling mounting, with integral swivel for field adjustment of motion detection coverage.
    a. Standard Range Sensors: Capable of detecting motion within a distance of 40 feet at a mounting height of 10 feet.
    b. Extended Range Sensors: Capable of detecting motion within a distance of 80 feet at a mounting height of 10 feet.
    c. High Bay Sensors: Capable of detecting motion within a distance of 50 feet at a mounting height of 30 feet.
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.

E. High-Bay Luminaire-Mounted Occupancy Sensors
1. Designed for direct luminaire installation and control, suitable for use with specified luminaires.
2. Passive infrared (PIR) type with a field of view of 360 degrees unless otherwise indicated.
3. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
4. Finish: White, unless otherwise indicated.

5. Circular Coverage Sensors: Capable of detecting motion within a distance of 40 feet at a mounting height of 20 feet.
6. Linear Aisle Coverage Sensors: Capable of detecting motion within an area of 20 feet wide by 60 feet long at a mounting height of 40 feet.

2.06 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. Atrium Photo Sensors: 200 to 2,500 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.

2.07 DIGITAL NETWORK LIGHTING CONTROLS

A. System Architecture:
1. Free topology plug-in wiring with green Cat 5e network cabling for power and data between control devices, switches, and sensors.
2. Self-configuring, digitally addressable control devices.
3. Any combination of inputs shall be programmable to any number of control devices.
4. Automatic configuration and connection of room loads to the connected control devices in the space without commissioning or the use of any tools.
5. Units shall not have any dip switches or potentiometers for field settings.

B. Sensors, power packs, and wall stations shall be interconnected through RJ-45 ports and comply with General Requirements section specified herein.

C. Network Lighting Control Processor
1. Description: 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.
a. Software shall be resident within the lighting control system.
b. 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.
c. 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.
d. 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.

2. 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.
3. Mount in surface enclosure provided by manufacturer.

D. Provide the following accessories as required for implementation of the control intent illustrated on the drawings.
   1. Wireless Configuration Tools: Handheld remote for device setting programming, two-way IR communication.
   2. I/O Module: Input / Output device. 24VDC relay with normally open, normally closed, and common outputs to indicate occupancy or lighting status to third party systems such as a BAS. Four input terminals for maintained or momentary switch closure inputs.
   3. Serial Data Interface: Provides RS-232 interface with third party AV and/or shade control systems.
   4. BACnet Appliance: Provides BACnet MS/TP digital networked communication between rooms, panels, Gateway, or BAS and automatically creates BACnet objects representative of connected devices.
   5. IP Gateway: BACnet to ethernet interface to allow web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.
   6. Programming and Configuration Software: PC-native application capable of accessing DLM control parameters within a room, for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication.

2.08 ACCESSORIES

A. Provide accessories as required for implementation of the control intent illustrated on the drawings.
B. Auxiliary Contacts:
   1. Comply with NEMA ICS 5.
   2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each lighting contactor, minimum.
C. Pilot Devices:
   1. Comply with NEMA ICS 5; heavy-duty type.
   2. Nominal Size: 30 mm.
   3. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
   4. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
   5. Indicating Lights: Push-to-test type unless otherwise indicated.
   6. Provide LED lamp source for indicating lights and illuminated devices.
D. Control and Timing Relays:
   1. Comply with NEMA ICS 5.
   2. Provide number and type of relays indicated or required to perform necessary functions.
   3. Timing Relays: Electronic or pneumatic as indicated.
      a. Adjustable Timing Range: As indicated on drawings.
E. Partition Switches: Indicates position of moveable partition for automatic grouping or separation of lighting in flexible use spaces.
F. Partition Controller: Provides manual or automatic coordination of spaces with up to four moveable walls by reconfiguring the connected digital switches and sensors.

PART 3 EXECUTION

3.01 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.

3.02 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.

3.03 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 0533.16 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 2726.
G. Provide required supports in accordance with Section 26 0529.
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 0553.
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 0533.16 for mounting of lighting control device system components.

3.04 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. Adjust position of directional occupancy sensors and outdoor motion sensors to achieve optimal coverage as required.
D. 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.
E. 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.

3.05 COMMISSIONING

A. See Section 01 9113 - General Commissioning Requirements for commissioning requirements.
B. Lighting controls must be 3rd party commissioned. Electrical Contractor shall arrange and pay for a third party commissioning and report.

3.06 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
B. See Section 01 7900 - 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 2100 - LOW-VOLTAGE ELECTRICAL SERVICE ENTRANCE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical service requirements.

1.02 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.

1.03 REFERENCE STANDARDS

A. IEEE C2 - National Electrical Safety Code; 2012.

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.

1.04 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.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Project Record Documents: Record actual locations of equipment and installed service routing.

1.06 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.

1.07 DELIVERY, STORAGE, AND HANDLING

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

B. Store products indoors in a clean, dry space having a uniform temperature to prevent condensation (including outdoor rated products which are not weatherproof until completely and properly installed). 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 products carefully to avoid damage to internal components, enclosure, and finish.

PART 2 PRODUCTS

2.01 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. Utility Company: Xcel Energy.
   1. Point of Contact: Alex J Welch.
   2. Phone: 701-241-8634.
   3. Email: Alec.J.Welch@xcelenergy.com.

D. 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 and installed by Contractor.
         3) Conductors: Furnished and installed by Utility Company.
      e. Pathway from Transformer to Pad-Mounted CT Cabinets: Furnished and installed by Contractor per Utility Company requirements
      f. 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: Utility Company metering is not applicable. Campus is primary metered.
      a. Meter Bases: Not applicable..

E. Products Furnished by Contractor: Comply with Utility Company requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings and configurations of service entrance equipment are consistent with the indicated requirements.

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

3.02 PREPARATION

3.03 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 underground electrical work in accordance with Section 26 0560.

E. Provide required support and attachment components in accordance with Section 26 0529.

F. Provide grounding and bonding for service entrance equipment in accordance with Section 26 0526.

G. Identify service entrance equipment, including main service disconnect(s) in accordance with Section 26 0553.

3.04 PROTECTION

A. Protect installed equipment from subsequent construction operations.

END OF SECTION

SECTION 26 2200 - LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General purpose transformers.

1.02 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 - 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 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

I. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.

J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.

L. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.03 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.

1.04 SUBMITTALS

A. See Section 01 3000 - 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. Vibration Isolators: Include attachment method and rated load and deflection.

C. Project Record Documents: Record actual locations of transformers.

1.05 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.

1.06 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

2.01 MANUFACTURERS

A. Eaton Corporation: www.eaton.com/#sle.
B. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
C. Siemens Industry, Inc: www.usa.siemens.com/#sle.
D. Substitutions: See Section 01 6000 - Product Requirements.

2.02 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.

2.03 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: Low sound levels at least 3 db less than NEMA ST 20 standard sound levels.
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 250: 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

3.01 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.

3.02 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 0533.13, 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 0529, 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 3000.
    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 0526.
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.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Inspect and test in accordance with NETA ATS, except Section 4.
C. Perform inspections and tests listed in NETA ATS Sections 7.2.1.1 and 7.2.1.2. Tests and inspections listed as optional are not required.
    1. 167 kVA single phase, 500 kVA three phase and smaller:
        a. Perform turns ratio tests at all tap positions.

3.04 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.

3.05 CLEANING

A. Clean dirt and debris from transformer 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 2413 - SWITCHBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.
B. Overcurrent protective devices for switchboards.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
C. Section 26 0529 - Hangers and Supports for Electrical Systems.
D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
E. Section 26 0573 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
F. Section 26 2300 - Low-Voltage Switchgear.
G. Section 26 2713 - Electricity Metering: For interface with equipment specified in this section.

1.03 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 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
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; 2013.
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.

1.04 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.

1.05 SUBMITTALS

A. See Section 01 3000 - 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 6000 - Product Requirements, for additional provisions.
2. Enclosure Keys: Two of each different key.

1.06 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.

1.07 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

2.01 MANUFACTURERS

A. Switchboards:
1. Eaton Corporation: www.eaton.com.
2. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
3. 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.

2.02 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. Front-Connected Switchboards:
1. Main Device(s): Individually-mounted.
2. Feeder Devices: Panel/group-mounted or individually-mounted.
3. Arrangement: Front accessible only (not rear accessible), rear aligned.
4. Gutter Access: Bolted covers.

E. 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.

F. 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.
G. 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 determined by short circuit study performed in accordance with Section 26 0573.
   2. Minimum Rating: 65,000 rms symmetrical amperes.
   3. Listed series ratings are not acceptable.
H. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
I. 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.
J. 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.
K. Conductor Terminations: Suitable for use with the conductors to be installed.
L. Enclosures:
   1. Environment Type per NEMA 250: 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.
M. 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.
N. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
O. 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.
P. Owner Metering: Comply with Section 26 2713.
Q. 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.

2.03 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.
        1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
    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 communication capability where indicated: Compatible with system indicated.
    e. Provide the following features and accessories where indicated or where required to complete installation:
        1) Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
        2) Pad-Lock Provision: For locking circuit breaker handle in OFF position. Provide lock-out accessory for all main and branch circuit breakers.
        3) Phase loss detection monitor..
    f. 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.
    g. 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.

2.04 SOURCE QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Factory test switchboards according to NEMA PB 2, including the following production (routine) tests on each switchboard assembly or component:
    1. Dielectric tests.
    2. Mechanical operation tests.
    3. Grounding of instrument transformer cases test.
    4. Electrical operation and control wiring tests, including polarity and sequence tests.
    5. Ground-fault sensing equipment test.

PART 3 EXECUTION

3.01 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.

3.02 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 0529.
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 3000.
H. Provide grounding and bonding in accordance with Section 26 0526.
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 circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed in accordance with Section 26 0573.
L. Set field-adjustable ground fault protection pickup and time delay settings as indicated.
M. Provide filler plates to cover unused spaces in switchboards.
N. Identify switchboards in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - 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. Test shunt trips to verify proper operation.
J. Correct deficiencies and replace damaged or defective switchboards or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
B. Adjust alignment of switchboard covers and doors.

3.05 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.

3.06 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
B. See Section 01 7900 - Demonstration and Training, for additional requirements.
C. Training: Train Owner's personnel on operation, adjustment, and maintenance of switchboard and associated devices.
    1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
    2. Provide minimum of four hours of training.
    3. Instructor: Manufacturer's authorized representative.
    4. Location: At project site.

END OF SECTION

SECTION 26 2416 - PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Power distribution panelboards.
B. Lighting and appliance panelboards.
C. Overcurrent protective devices for panelboards.

1.02 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 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
E. NEMA PB 1 - Panelboards; 2011.
F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 1000 Volts 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.

1.03 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.

1.04 SUBMITTALS

A. See Section 01 3000 - 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 6000 - Product Requirements, for additional provisions.
   2. Panelboard Keys: Two of each different key.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.06 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.

1.07 FIELD CONDITIONS

A. Maintain ambient temperature within the following limits during and after installation of panelboards:
   1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation: www.eaton.com.

B. Schneider Electric; Square D Products: www.schneider-electric.us.

C. Siemens Industry, Inc: www.usa.siemens.com.

D. Substitutions: See Section 01 6000 - Product Requirements.

2.02 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 determined by short circuit study performed in accordance with Section 26 0573.
   2. Listed series ratings are not acceptable.

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 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: 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 4300, 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. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

N. 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.

O. Load centers are not acceptable.

2.03 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.
   2. Provide thermal magnetic circuit breakers unless otherwise indicated.
   3. Provide electronic trip circuit breakers for circuit breaker frame sizes 400 amperes and above.

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.

2.04 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.

2.05 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.
      a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
   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.
      b. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
   9. Do not use tandem circuit breakers.
   10. Do not use handle ties in lieu of multi-pole circuit breakers.
   11. Provide the following features and accessories where indicated or where required to complete installation:
      a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
      b. Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.

PART 3 EXECUTION

3.01 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.

3.02 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 0529.
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 3000.
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 0526.
    1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
    2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.
L. Install all field-installed branch devices, components, and accessories.
M. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 0573.
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. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads. Also provide for the following:
    1. Emergency and night lighting circuits.
    2. Fire detection and alarm circuits.
    3. Communications equipment circuits.
    4. Intrusion detection and access control system circuits.
    5. Video surveillance system circuits.
Q. Identify panelboards in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - 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. Test shunt trips to verify proper operation.
E. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.04 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.

3.05 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

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SECTION 26 2513 - LOW-VOLTAGE BUSWAYS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Plug-in track busway.

B. Plug-in units for plug-in track busway.

1.02 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NECA 408 - Standard for Installing and Maintaining Busways; 2015.

C. NEMA BU 1.1 - General Instructions for Handling, Installation, Operation, and Maintenance of Busway Rated 600 Volts or Less; 2010.

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

F. UL 857 - Busways; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the arrangement of busway with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others. Coordinate the work with other trades to avoid installation of obstructions within busway required clearances.
2. Coordinate arrangement of busway 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. Where busway extends through roof, 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.
6. Notify of any conflicts with or deviations Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week prior to performing field measurements for busway fabrication drawings; require attendance of all affected installers. Review proposed routing, sequence of installation, and protection requirements for installed busway.

C. Sequencing:

1. Perform field measurements prior to busway fabrication. Where necessary, perform field measurement for custom lengths after installation of adjacent sections.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for busway system components and accessories. Include dimensions, weight, materials, fabrication details, finishes, and service condition requirements. Indicate voltage and current ratings, short circuit current ratings, configurations, and installed features and accessories.

C. Shop Drawings: Include dimensioned plan views and sections indicating proposed busway routing, required clearances, and locations and details of supports, fittings, building element penetrations, and equipment connections.

D. Project Record Documents: Record actual routing of busway.

1. Include actual installed locations of plug-in units.

1.05 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.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store busway in accordance with manufacturer's instructions, NECA 408, and NEMA BU 1.1.

B. Store products indoors in a clean, dry space having a uniform temperature to prevent condensation (including outdoor busway, which is not weatherproof until completely and properly installed). 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 products carefully to avoid damage to internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Track Busway System:
   1. Starline Power by Legrand: https://starlinepower.com/.
   2. Substitutions: See Section 01 6000 - Product Requirements.

2.02 BUSWAY SYSTEM

A. Provide new track busway system consisting of all required components, fittings, devices, supports, accessories, etc. as necessary for a complete operating system.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Description: Prefabricated sectionalized enclosed bus assemblies and associated fittings and devices; listed and labeled as complying with UL 857. Busway shall have a continous access slot allowing power to be tapped at any location along the lenght of the busway section.

D. Busway General Requirements:
   1. Busway Type: Totally enclosed, non-ventilated; suitable for installation in any mounting orientation the busway is designed for (e.g horizontal flatwise, horizontal edgewise, vertical) without derating.
   2. Temperature Rise: Not exceeding 55 degrees C, when operating at continuous rated current in an ambient temperature of 104 degrees F.
   3. Busbars to be suitably plated at all electrical contact points.
   4. Busbar Insulation: NEMA Class B, rated 266 degrees F.
   5. Rating: voltage as indicated on Drawings. Ampacity: 60-100 amps.
   6. Housing: Steel or aluminum, with manufacturer's standard finish unless otherwise indicated.
   7. Single-Bolt Type Joints:
      a. Use torque-indicating bolts with visual indication that proper torque has been applied.
      b. Bolts to be at ground potential to allow adjustment without requiring de-energizing of busway.
      c. Designed such that tightening of joints only requires access to one side of busway.
      d. Allows for length adjustment of plus/minus 0.125 inch.

E. Service Conditions:
   1. Provide busway system and associated components suitable for operation under the following service conditions without derating:
      a. Altitude: Less than 6,600 feet.
      b. Ambient Temperature:
         1) Busway Lengths and Fittings: Between -22 degrees F and 104 degrees F.
         2) Circuit Breaker Plug-In Units: Between 32 degrees F and 104 degrees F.
   2. Provide busway system and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

F. Short Circuit Current Rating:
   1. Provide busway system and associated components with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.
   2. Label equipment utilizing series ratings as required by NFPA 70.

2.03 PLUG-IN UNITS FOR PLUG-IN BUSWAY

A. Description: Plug-in units suitable for use with installed busway; types, ratings, configurations, and features as indicated on the drawings.

B. General Requirements:
   1. Designed to make positive ground connection prior to phase/neutral connections when installed.
   2. Where splash resistant busway is specified, provide splash resistant plug-in units with minimum IEC 60529 rating of IP 54 unless otherwise indicated.

C. Circuit Breaker Plug-In Units:
   1. Provide safety interlock to prevent opening the cover with the unit in the ON position with capability of overriding interlock for testing purposes.
   2. Provide mechanical interlock for plug-in units up to 250 A to prevent installation or removal with the unit in the ON position.
   3. Conductor Terminations: Suitable for use with the conductors to be installed.
   4. Provide insulated 100 percent capacity solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
   5. Provide solidly bonded equipment ground bus with suitable lug for terminating equipment grounding conductor.
   6. Provide thermal magnetic circuit breakers unless otherwise indicated.
   7. 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.
      b. Interrupting Capacity:
         1) Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
            (a) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
         2) Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
      c. Conductor Terminations:
         1) Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
      d. 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.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that the ratings of busway system components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive busway and associated supports.

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

3.02 INSTALLATION

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

B. Install busway in accordance with NECA 1 (general workmanship), NECA 408, and NEMA BU 1.1.

C. Unless otherwise indicated, arrange busway to be parallel or perpendicular to building lines.

D. Arrange busway to provide required clearances and maintenance access.

E. Install busway plumb and level, with sections aligned and with horizontal runs at the proper elevation.

F. Maintain proper phase sequence throughout busway system, accounting for phase transitions where applicable.

G. Provide suitable expansion fittings where busway is subject to movement, including but not limited to:
   1. Where busway crosses structural joints intended for expansion.
   2. Long straight busway runs in accordance with manufacturer's instructions.

H. Provide end closures at unconnected ends of busway runs.

I. Busway Support:
   1. Use manufacturer's recommended hangers and supports, located at intervals complying with NFPA 70 and manufacturer's requirements. Provide required support and attachment in accordance with Section 26 0529, where not furnished by busway manufacturer.

2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Provide sway bracing as indicated or as required to keep busway runs straight and prevent rotation and movement, accounting for unbalanced weight distribution of plug-in units where applicable.

J. Penetrations:
1. Provide suitable flanges where busway penetrates building elements. Use weatherproof flanges for exterior wall or roof penetrations. Seal roof penetrations as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
2. Install firestopping to preserve fire resistance rating of building elements, using materials and methods specified in Section 07 8400.
3. Where busway penetrates floor, provide 4 inch high concrete curb constructed in accordance with Section 03 3000 around openings in accordance with NFPA 70.

K. Plug-In Units:
1. Install plug-in units on plug-in busway in accordance with manufacturer's instructions. Provide independent supports where recommended by manufacturer.
2. Unless otherwise indicated, final connections from plug-in units to loads to be provided by Contractor.

L. Provide grounding and bonding in accordance with Section 26 0526.
1. Where integral housing ground is utilized, verify joint covers and other components required for continuity are properly installed.

M. Identify busway in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Electrically isolate busway system before energizing and perform insulation resistance testing in accordance with NECA 408 and NEMA BU 1.1.

C. Perform infrared scanning of energized busway system under maximum load conditions in accordance with NECA 408.

D. Correct deficiencies and replace damaged or defective busway system components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

B. Adjust supports as required to minimize strain on busway and associated components.

3.05 CLEANING

A. Clean dirt and debris from busway enclosure and components in accordance with manufacturer's instructions. Do not use compressed air or a blower in order to prevent debris infiltration.

B. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. See Section 01 7900 - Demonstration and Training, for additional requirements.

B. Training: Train Owner's personnel on operation, adjustment, 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.

3.07 PROTECTION

A. Protect busway system from subsequent construction operations.

END OF SECTION

SECTION 26 2713 - ELECTRICITY METERING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Equipment for Owner electricity metering:
   1. Single circuit electricity meters.

1.02 REFERENCE STANDARDS

A. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate work to provide equipment suitable for interface with electricity metering systems to be provided.
   2. Coordinate the work with other installers to provide communication lines required for electricity metering system interface.
   3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for electricity metering systems and associated components and accessories. Include ratings, configurations, standard wiring diagrams, dimensions, service condition requirements, and installed features.
C. Shop Drawings: Include system interconnection schematic diagrams showing all factory and field connections. Include requirements for interface with other systems.
D. Project Record Documents: Record actual installed locations of meters and final equipment settings.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.
B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.07 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Electricity Meters- Other Acceptable Manufacturers:
   1. Veris Industries: {\hl\#1}.
   2. Electro Industires:https://electroind.com
   3. Same as manufacturer of electrical distribution equipment used for this project.
      a. Eaton Corporation: www.eaton.com/#sle.
      b. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
      c. Siemens Industry, Inc: www.usa.siemens.com/#sle.
B. Substitutions: See Section 01 6000 - Product Requirements.

2.02 EQUIPMENT FOR OWNER ELECTRICITY METERING

A. Provide microprocessor-based digital electricity metering systems including all instrument transformers, wiring, and connections necessary for measurements specified.
B. Provide products listed, classified, and labeled as suitable for the purpose intended.
C. Provide electricity metering systems and associated components compatible with the equipment and associated circuits to be metered.

D. Service Conditions: Provide electricity meters suitable for operation under the service conditions at the installed location.

E. Enclosures:
   1. Where not furnished by manufacturer, provide required cabinets and enclosures in accordance with Section 26 0533.16.
   2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   3. Finish: Manufacturer's standard unless otherwise indicated.

F. Instrument Transformers:
   1. Comply with IEEE C57.13, where applicable.
   2. Select suitable ratio, burden, and accuracy as required for connected devices.
   3. Current Transformers: Compatible with connected meters; replace meters damaged by connection of incompatible current transformers. Provide shorting terminal blocks for connection of secondaries where applicable.
   4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

2.03 SINGLE CIRCUIT ELECTRICITY METERS

A. Single Circuit Electricity Meter:
   1. Basis of Design: Shark 250 V2.
   2. Accuracy:
      a. Meter shall be UL listed and CE marked. Meter shall have third party lab testing and/or certification for the following standards
      b. ANSI C12.20 2015 0.1 Accuracy Class and ANSI C12.20 2014
         1) IEC 62053-22 0.2S Class Accuracy
         2) FCC Part 15, Class B (Radiated and Conducted Emissions)
         3) ANSI (IEEE) C37.90.1 (Surge Withstand)
         4) ANSI C62.41 (Surge Immunity)
         5) IEC 62053-23
         6) IEC 61326-1, IEC 61000-6-2, IEC 61000-6-4, and subordinate standards.
      c. Meter shall have certified accuracy of +/- 0.1% or better for voltage and current, and 0.1% for power and energy. Meter shall meet accuracy requirements of ANSI C12.20 (Class 0.1 CL) and IEC 62053-22 (Class 0.2S). Meter shall have frequency accuracy of 0.007 Hz.
         1) Meter shall provide sampling at 400+ samples per cycle on all channels measured readings simultaneously.
         2) Meter shall utilize 24-bit Analog to Digital converters.
         3) Meter shall be a traceable revenue meter, containing a utility-grade test pulse for accuracy verification.
   3. Measured Parameters:
      a. Voltage (Volts AC); line-to-line and line-to-neutral; per phase.
      b. Current (Amps); per phase.
      c. Frequency (Hz).
      d. Real/active power (kW); per phase and total of all phases.
      e. Reactive power (kVAR); per phase and total of all phases.
      f. Apparent power (kVA); per phase and total of all phases.
      g. Power factor; per phase and total of all phases.
      h. Real/active energy (kWh).
      i. Reactive energy (kVARh).
      j. Apparent energy (kVAh).
      k. Power demand; real/active and apparent; present and maximum.
      l. Current demand.
      m. Meter shall provide THD harmonic magnitude voltage and current recording to the 40th order.
      n. Meter shall provide a simultaneous voltage and current waveform recorder, capable of recording 512 samples per cycle for a voltage sag or swell or for a current fault event.

1) Meter shall provide programmable pre- and post-event recording capability.
2) Meter shall have an advanced DSP design that allows power quality triggers to be based on a 1/2 cycle updated RMS.
3) Meter shall record up to 319 waveform events.
4) Meter shall store waveform data in a first-in, first-out circular buffer to ensure that data is always being recorded.

4. Meter shall provide user configured fixed window or rolling window demand to set up the specific utility demand profile.
5. Meter shall internally record and store time of use data in a perpetual TOU calendar. TOU shall support.
   a. Bi-directional consumption and demand.
   b. Configurable accumulators.
   c. Up to four seasons and 12 months.
   d. Cumulative demand and continuous cumulative demand shall be available.
6. Data logging.
   a. Meter shall have up to 128 MB memory for logging. Meter shall have a real-time clock that allows for timestamping of all data in the meter when log events are created.
      1) Meter shall have up to six programmable historical logs for trending profiles. Each log shall allow up to 64 parameters. User shall be able to allocate memory between historical logs. Duration of a historical log with 4 data channels being recorded at 15-minute intervals shall be 76 months.
      2) Meter shall have a log for Limits/Alarms. Log shall record up to 2048 events.
      3) Meter shall have an anti-tampering log / system events log, recording the following with a timestamp: Demand Resets, Password Requests, System Startup, Energy Resets, Log Resets, Log Reads, Programmable Settings Changes, Critical Data Repairs.
      4) Meter shall record I/O changes up to 2048 events.
7. Communications: Compatible with connected systems. Provide all accessories necessary for proper interface.
   a. Ethernet Communications: Support for Modbus TCP protocol.
8. Display
   a. The meter shall include a display capable of displaying the Measured Parameters.

B. Software
   1. The meter shall have Microsoft Windows based software available for remote monitoring, configuration and graphing of the meter via Ethernet.
   2. Must support exporting of data to a .csv file.
   3. Meter shall provide multi-level encrypted Cyber security.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that the ratings and configurations of metering systems and associated components are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive meters.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Provide required support and attachment components in accordance with Section 26 0529.
D. Provide grounding and bonding in accordance with Section 26 0526.
E. Provide fuses complying with Section 26 2813 as required.
F. Identify meters and associated wiring in accordance with Section 26 0553.
G. Meters shall be placed into services under supervision of factory certified installation professional.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.
C. Meters: Perform inspections and tests listed in NETA ATS, Section 7.11.2.
D. 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.
E. Correct deficiencies and replace damaged or defective metering system components.

3.04 ADJUSTING

A. Program system parameters according to requirements of Owner.

3.05 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.06 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
B. See Section 01 7900 - Demonstration and Training, for additional requirements.
C. Training: Train Owner's personnel on operation, adjustment, 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 authorized representative.
    4. Location: At project site.

3.07 PROTECTION

A. Protect installed system components from subsequent construction operations.

END OF SECTION

SECTION 26 2726 - WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall switches.
B. Receptacles.
   1. Straight blade receptacles.
   2. GFCI type receptacles.
C. Wall plates.
D. Floor box service fittings.
E. Poke-through assemblies.
F. Cord and Plug Sets
G. Device plates and decorative box covers

1.02 REFERENCE STANDARDS

A. FS W-C-596 - Connector, Electrical, Power, General Specification for; 2014h, with Amendments (2017).
B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification); 2014g, with Amendment (2017).
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 (R2015).
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.

1.03 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. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
   6. 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.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
C. Project Record Documents: Record actual installed locations of wiring devices.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.
B. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.06 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.01 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 GFCI protection for receptacles installed within 6 feet of sinks.
D. Provide GFCI protection for receptacles installed in kitchens.
E. Provide GFCI protection for receptacles serving electric drinking fountains.
F. Unless noted otherwise, do not use combination switch/receptacle devices.
G. For flush floor service fittings, use tile rings for installations in tile floors.
H. For flush floor service fittings, use carpet flanges for installations in carpeted floors.

2.02 WIRING DEVICE FINISHES

A. Provide wiring device finishes as described below unless otherwise indicated.
B. Wiring Devices, Unless Otherwise Indicated: White with stainless steel wall plate.

2.03 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.
C. Lighted Wall Switches: Industrial specification grade, 20 A, 120/277 V with illuminated standard toggle type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
D. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.04 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.
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.

2.05 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. Stainless Steel Wall Plates : Brushed satin finish, Type 302 stainless steel.
C. 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.

D. 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.

2.06 FLOOR BOX SERVICE FITTINGS

A. Description: Service fittings compatible with floor boxes provided under Section 26 0533.16 with components, adapters, and trims required for complete installation.

B. Above-Floor Service Fittings:
   1. Single Service Pedestal Convenience Receptacles:
      a. Configuration: One standard convenience duplex receptacle.
   2. Single Service Pedestal Communications Outlets:
      a. Configuration: One 1 inch bushed opening.
   3. Single Service Pedestal Furniture Feed:
      a. Configuration: One 3/4 inch knockout.
   4. Dual Service Pedestal Combination Outlets:
      a. Configuration:
         1) Power: One standard convenience duplex receptacle.
         2) Communications: One 1 inch bushed opening.
         3) Voice and Data Jacks: As specified in Section 27 1000.
      b. Provide barrier to separate line and low voltage compartments.

C. Flush Floor Service Fittings:
   1. Single Service Flush Convenience Receptacles:
      a. Cover: Rectangular.
      b. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
   2. Single Service Flush Communications Outlets:
      a. Cover: Rectangular.
      b. Voice and Data Jacks: As specified in Section 27 1000.
   3. Dual Service Flush Combination Outlets:
      a. Cover: Rectangular.
      b. Configuration:
         1) Power: One standard convenience duplex receptacle(s) with duplex flap opening(s).
         2) Voice and Data Jacks: As specified in Section 27 1000.
   4. Dual Service Flush Furniture Feed:
      a. Cover: Rectangular.
      b. Configuration:
         1) Power: One 2-1/8 inch by 3/4 inch combination threaded opening(s).
         2) Communications: One 2-1/8 inch by 1 inch combination threaded opening(s).
   5. Accessories:
      a. Tile Rings: Finish to match covers; configuration as required to accommodate specified covers.
      b. Carpet Flanges: Finish to match covers; configuration as required to accommodate specified covers.

2.07 POKE-THROUGH ASSEMBLIES

A. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.

B. Flush Floor Service Fittings:
   1. Single Service Flush Convenience Receptacles:
      a. Configuration: One standard convenience duplex receptacle(s) with duplex flap opening(s).
   2. Single Service Flush Communications Outlets:
      a. Voice and Data Jacks: As specified in Section 27 1000.
   3. Single Service Flush Furniture Feed:
      a. Configuration: One 2 inch by 1-1/4 inch combination threaded opening(s).
   4. Dual Service Flush Combination Outlets:
      a. Cover: Hinged door(s).

b. Configuration:
1) Power: One standard convenience duplex receptacle(s).
2) Voice and Data Jacks: As specified in Section 27 1000.
5. Dual Service Flush Furniture Feed:
a. Configuration:
1) Power: One 3/4 inch threaded opening(s).
2) Communications: Two 1/2 inch threaded opening(s).
6. Accessories:
a. Closure Plugs: Size and fire rating as required to seal unused core hole and maintain fire rating of floor.

PART 3 EXECUTION

3.01 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.

3.02 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.

3.03 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 0533.16 as required for installation of wiring devices provided under this section.
1. Mounting Heights: Unless otherwise indicated, as follows:
a. Wall Switches: 46 inches above finished floor to centerline of device.
b. Wall Dimmers: 46 inches above finished floor to centerline of device.
c. Fan Speed Controllers: 46 inches above finished floor to centerline of device.
d. Receptacles: 18 inches above finished floor to centerline of device, 6 inches above countertop, or 4 inches above backsplash. 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.
N. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.

3.04 FIELD QUALITY CONTROL

A. See Section 01 4000 - 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.

3.05 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.

3.06 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

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SECTION 26 2816.13 - ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed circuit breakers.

1.02 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. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
I. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.
J. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
    1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within 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. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted enclosed circuit breakers 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.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.
    1. Include characteristic trip curves for each type and rating of circuit breaker upon request.
C. Project Record Documents: Record actual installed locations of enclosed circuit breakers.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.06 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 circuit breaker internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation: www.eaton.com/#sle.
B. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.

C. Siemens Industry, Inc: www.usa.siemens.com/#sle.
D. Source Limitations: Furnish enclosed circuit breakers and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ENCLOSED CIRCUIT BREAKERS

A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
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 23 degrees F and 104 degrees F.
D. Short Circuit Current Rating:
   1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.
E. Enclosed Circuit Breakers Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
F. Conductor Terminations: Suitable for use with the conductors to be installed.
G. Provide thermal magnetic circuit breakers unless otherwise indicated.
H. Provide electronic trip circuit breakers where indicated.
I. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.
J. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.
   2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
   3. Provide surface-mounted enclosures unless otherwise indicated.
K. Provide externally operable handle with means for locking in the OFF position.

2.03 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.
B. Interrupting Capacity:
   1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
      a. 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
      b. 14,000 rms symmetrical amperes at 480 VAC.
   2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
C. Conductor Terminations:
   1. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
D. 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.
   1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
E. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
F. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
G. Elevator Disconnect Shunt-Trip Breakers: Provide enclosed shunt-trip breaker with auxiliary contacts
H. Provide the following circuit breaker types where indicated:

1. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
2. Ground Fault Equipment Protection Circuit Breakers: Designed to trip at 30 mA for protection of equipment.
3. Current Limiting Circuit Breakers: Without using fusible elements, designed to limit the let-through energy to a value less than the energy of a one-half cycle wave of the symmetrical prospective current when operating within its current limiting range.

I. Provide the following features and accessories where indicated or where required to complete installation:
1. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
2. Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
3. Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
4. Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 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 0529.
E. Install enclosed circuit breakers plumb.
F. Install flush-mounted enclosed circuit breakers so that trims fit completely flush to wall with no gaps and rough opening completely covered.
G. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
H. Provide grounding and bonding in accordance with Section 26 0526.
I. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 0573.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Inspect and test in accordance with manufacturer's instructions and NETA ATS, except Section 4.
C. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers used for service entrance and for circuit breakers larger than 225 amperes. Tests listed as optional are not required.
D. Test GFCI circuit breakers to verify proper operation.
E. Test shunt trips to verify proper operation.
F. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from circuit breaker 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 2816.16 - ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed safety switches.

B. Shunt trip elevator switches.

1.02 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013.

D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.

E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.

1.03 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.

1.04 SUBMITTALS

A. See Section 01 3000 - 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.

1.05 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.

1.06 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.

1.07 FIELD CONDITIONS

A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation: www.eaton.com.
B. Schneider Electric; Square D Products: www.schneider-electric.us.
C. Siemens Industry, Inc: www.usa.siemens.com.
D. Substitutions: See Section 01 6000 - Product Requirements.

2.02 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.
    2. Minimum Ratings:
        a. Heavy Duty Single Throw Switches Protected by Class R, Class J, Class L, or Class T Fuses: 200,000 rms symmetrical amperes.
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 250, and list and label as complying with UL 50 and UL 50E.
    1. Environment Type per NEMA 250: 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 KS 1.
    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.

2.03 SHUNT TRIP ELEVATOR SWITCHES

A. Comply with ASME A17.1, UL 98.
B. Switch Assemblies: NEMA KS1, UL 98, ASME A17.1, 600V, single-throw, three-pole, horsepower-rated, with 200 kA interrupting and short-circuit current rating when fitted with Class J fuses.
    1. Integral shunt trip mechanism and Class J fuse block
    2. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
    3. Handle lockable in OFF position.

4. Control Circuit: Integral control power transformer, with primary and secondary fuses, and sufficient capacity to operate shunt trip, connected pilot light, and indicating and control devices.
5. Accessories:
    a. Oiltight keyed test switch
    b. Oiltight red ON pilot light.
    c. Isolated 100 percent rated neutral lug
    d. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
    e. Form C alarm contacts that change state when the switch is tripped.
    f. Three-pole, double-throw, fire safety and alarm relay, 120V AC coil voltage.
    g. Three-pole, double-throw, fire alarm voltage monitoring relay complying with NFPA 72.

PART 3 EXECUTION

3.01 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.

3.02 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 0529.
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 0526.
H. Provide fuses complying with Section 26 2813 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
I. Identify enclosed switches in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Inspect and test in accordance with NETA ATS, except Section 4.
C. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 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 2913 - ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Enclosed NEMA controllers for low-voltage (600 V and less) applications:
   1. Magnetic motor starters.
   2. Manual motor starters.
   3. Motor-starting switches without overload protection.

B. Overcurrent protective devices for motor controllers, including overload relays.

1.02 REFERENCE STANDARDS

A. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.

D. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2000 (R2005), with errata, 2008.

E. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices; 2000 (R2010).

F. NEMA ICS 6 - Industrial Control and Systems: Enclosures; 1993 (R2011).

G. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.

H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

J. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules; Current Edition, Including All Revisions.

K. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters; Current Edition, Including All Revisions.

1.03 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 the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.
   3. Coordinate the work to provide controllers and associated wiring suitable for interface with control devices to be installed.
   4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   6. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.

C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include dimensioned plan and elevation views of enclosed controllers and adjacent equipment with all required clearances indicated.

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 controllers and final equipment settings.

1. Include nameplate data of actual installed motors and associated overload relay selections and settings.
2. Motor Circuit Protectors: Include magnetic instantaneous trip settings.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.06 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 internal components, enclosure, and finish.

1.07 FIELD CONDITIONS

A. Maintain field conditions within required service conditions during and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation: www.eaton.com.

B. General Electric Company: www.geindustrial.com.

C. Rockwell Automation, Inc; Allen-Bradley Products: ab.rockwellautomation.com.

D. Schneider Electric; Square D Products: www.schneider-electric.us.

E. Siemens Industry, Inc: www.usa.siemens.com.

2.02 ENCLOSED CONTROLLERS

A. Provide enclosed controller assemblies 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: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.

D. Service Conditions:
   1. Provide controllers and associated components suitable for operation under the following service conditions without derating:
      a. Altitude:
         1) Class 1 Km Equipment (devices utilizing power semiconductors, e.g. variable frequency controllers): Less than 3,300 feet.
         2) Class 2 Km Equipment (electromagnetic and manual devices): Less than 6,600 feet.
      b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
   2. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.

E. Short Circuit Current Rating:
   1. Provide controllers with listed short circuit current rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.

F. Conductor Terminations: Suitable for use with the conductors to be installed.

G. Enclosures:
   1. Comply with NEMA ICS 6.
   2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
   3. Finish: Manufacturer's standard unless otherwise indicated.

H. 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.

I. Magnetic Motor Starters: Combination type unless otherwise indicated.
   1. Combination Magnetic Motor Starters: NEMA ICS 2, Class A combination motor controllers with magnetic contactor(s), externally operable disconnect and overload relay(s).
   2. Configuration: Full-voltage non-reversing unless otherwise indicated.

3. Disconnects: Circuit breaker type.
    a. Circuit Breakers: Motor circuit protectors (magnetic-only) unless otherwise indicated or required.
    b. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
    c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
4. Overload Relays: Bimetallic thermal type unless otherwise indicated.
5. Pilot Devices Required:
    a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings.
    b. Single-Speed, Non-Reversing Starters:
        1) Pushbuttons: START-STOP.
        2) Selector Switches: HAND/OFF/AUTO.
        3) Indicating Lights: Red ON, Green OFF.

J. Manual Motor Starters:
1. Description: NEMA ICS 2, Class A manually-operated motor controllers with overload relay(s).
2. Configuration: Non-reversing unless otherwise indicated.
3. Fractional-Horsepower Manual Motor Starters:
    a. Furnish with toggle operator.
    b. Overload Relays: Bimetallic or melting alloy thermal type.
    c. Provide means for locking operator in the OFF position.
    d. Furnish Red ON indicating light where not within sight of equipment.
4. Integral-Horsepower Manual Motor Starters:
    a. Furnish with toggle or pushbutton operator.
    b. Overload Relays: Bimetallic or melting alloy thermal type.
    c. Provide means for locking operator in the OFF position.
    d. Furnish Red ON indicating light where not within sight of equipment.

K. Motor-Starting Switches: Horsepower-rated switches without overload protection; toggle operator.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Overload Relays:
1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
3. Trip-free operation.
4. Visible trip indication.
5. Resettable.
    a. Employ manual reset unless otherwise indicated.
    b. Do not employ automatic reset with two-wire control.
6. Bimetallic Thermal Overload Relays:
    a. Interchangeable current elements/heaters.
    b. Adjustable trip; plus/minus 10 percent of nominal, minimum.
    c. Trip test function.
7. Melting Alloy Thermal Overload Relays:
    a. Interchangeable current elements/heaters.
8. Solid-State Overload Relays:
    a. Selectable inverse-time trip class rating; available ratings of Class 10, 20, and 30, minimum.
    b. Adjustable full load current.
    c. Phase loss protection.
    d. Phase imbalance protection.
    e. Ambient temperature insensitive.
    f. Thermal memory.
    g. Trip test function.

h. Provide isolated alarm contact.

B. Circuit Breakers:
   1. Interrupting Capacity (not applicable to motor circuit protectors):
      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. Motor Circuit Protectors:
      a. Description: Instantaneous-trip circuit breakers furnished with magnetic instantaneous tripping elements for short circuit protection, but not with thermal inverse time tripping elements for overload protection; UL 489 recognized only for use as part of a listed combination motor controller with overload protection; ratings, configurations, and features as indicated on the drawings.
      b. Provide field-adjustable magnetic instantaneous trip setting.

2.04 CONTROL ACCESSORIES

A. Auxiliary Contacts:
   1. Comply with NEMA ICS 5.
   2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.

B. Pilot Devices:
   1. Comply with NEMA ICS 5; heavy-duty type.
   2. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
   3. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
   4. Indicating Lights: Push-to-test type unless otherwise indicated.
   5. Provide LED lamp source for indicating lights and illuminated devices.

C. Control and Timing Relays:
   1. Comply with NEMA ICS 5.
   2. Provide number and type of relays indicated or required to perform necessary functions.

D. Control Power Transformers:
   1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices, plus 50 VA spare capacity.
   2. Include primary and secondary fuses.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that ratings of enclosed controllers are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive enclosed controllers.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install controllers 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 0529.
E. Install enclosed controllers plumb and level.
F. Provide grounding and bonding in accordance with Section 26 0526.
G. Install all field-installed devices, components, and accessories.
H. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

I. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.
J. Identify enclosed controllers in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Inspect and test in accordance with NETA ATS, except Section 4.
C. Motor Starters: Perform inspections and tests listed in NETA ATS, Section 7.16.1.1. Tests listed as optional are not required.
D. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers larger than 400 amperes. Tests listed as optional are not required.
E. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.

3.04 CLEANING

A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.
B. Repair scratched or marred exterior surfaces to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
B. See Section 01 7900 - Demonstration and Training, for additional requirements.
C. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.
D. Training: Train Owner's personnel on operation, adjustment, and maintenance of enclosed controllers and associated devices.
    1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

END OF SECTION

SECTION 26 3213 - ENGINE GENERATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Packaged engine generator system and associated components and accessories:
   1. Engine and engine accessory equipment.
   2. Alternator (generator).
   3. Generator set control system.
   4. Generator set enclosure.
   5. BAS Interface

B. Factory assembled walk-in style enclosure to be included as Alternate Bid.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
C. Section 26 0529 - Hangers and Supports for Electrical Systems.
D. Section 26 0548 - Vibration and Seismic Controls for Electrical Systems.
E. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
F. Section 26 3600 - Transfer Switches.

1.03 REFERENCE STANDARDS

A. ASTM D975 - Standard Specification for Diesel Fuel; 2023a.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NECA/EGSA 404 - Standard for Installing Generator Sets; 2014.
D. NEMA MG 1 - Motors and Generators; 2017.
E. NFPA 30 - Flammable and Combustible Liquids Code; 2024.
F. NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; 2021.
G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
H. NFPA 99 - Health Care Facilities Code; 2015.
I. NFPA 110 - Standard for Emergency and Standby Power Systems; 2016.
J. UL 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids; Current Edition, Including All Revisions.
K. UL 1236 - Battery Chargers for Charging Engine-Starter Batteries; Current Edition, Including All Revisions.
L. UL 2200 - Stationary Engine Generator Assemblies; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of generator sets to be installed with work provided under other sections or by others.
      a. Transfer Switches: See Section 26 3600.
   2. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for engine generator system.
   3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work to provide electrical circuits suitable for the power requirements of the actual auxiliary equipment and accessories to be installed.
   5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features. Include alternator starting capabilities, engine fuel consumption rates, and cooling, combustion air, and exhaust

requirements.
   1. Include generator set sound level test data.
   2. Include characteristic trip curves for overcurrent protective devices upon request.
   3. Include alternator thermal damage curve.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.
D. Derating Calculations: Indicate ratings adjusted for applicable service conditions.
E. Fuel Storage Tank Calculations: Indicate maximum running time for generator set configuration provided.
F. Specimen Warranty: Submit sample of manufacturer's warranty.
G. 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 operation of product.
H. Manufacturer's factory emissions certification.
I. Source quality control test reports.
J. Provide NFPA 110 required documentation from manufacturer, including but not limited to:
   1. Certified prototype tests.
   2. Torsional vibration compatibility certification.
   3. NFPA 110 compliance certification.
   4. Certified rated load test at rated power factor.
K. Manufacturer’s detailed field testing procedures.
L. Field quality control test reports.
M. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
N. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
O. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

1.06 QUALITY ASSURANCE

A. Comply with the following:
   1. NFPA 70 (National Electrical Code).
   2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for Level 1 system.
   3. NFPA 99 (Health Care Facilities Code).
   4. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
   5. NFPA 30 (Flammable and Combustible Liquids Code).
B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years experience.
   1. Authorized service facilities located within 200 miles of project site.
C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store generator sets in accordance with manufacturer's instructions and NECA/EGSA 404.
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 instructions to avoid damage to generator set components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Packaged Engine Generator Set:
   1. Caterpillar Inc: www.cat.com/#sle.
   2. Cummins Power Generation Inc: www.cumminspower.com/#sle.
   3. MTU Onsite Energy, a Brand of Rolls-Royce Power Systems: www.mtuonsiteenergy.com/#sle.

B. Substitutions: See Section 01 6000 - Product Requirements.

C. Products other than basis of design are subject to compliance with specified requirements and prior approval of Engineer. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

D. Source Limitations: Furnish engine generator sets and associated components and accessories produced by a single manufacturer and obtained from a single supplier.

2.02 PACKAGED ENGINE GENERATOR SYSTEM

A. Provide new engine generator system consisting of all required equipment, sensors, conduit, boxes, wiring, piping, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. System Description:
   1. Application: Emergency/standby.
   2. Configuration: Single packaged engine generator set operated independently (not in parallel).
   3. Total System Power Rating: 150 kW, standby.
   4. Where design is based on single generator set, use of multiple, smaller unit(s) operated in parallel to obtain equivalent total system power rating is not permitted.

D. Packaged Engine Generator Set:
   1. Type: Diesel (compression ignition).
   2. Power Rating: As indicated on drawings, standby, including applicable derating adjustments.
   3. Voltage: 480Y/277 V, 3 phase, 60 Hz.
   4. Main Line Circuit Breaker:
      a. Type: Electronic trip with long time and short time delay and instantaneous pickup.
      b. Trip Rating: Select according to generator set rating.
      c. Features:
         1) Shunt trip.
         2) Auxiliary contacts.

E. Generator Set General Requirements:
   1. Prototype tested in accordance with NFPA 110 for Level 1 systems.
   2. Factory-assembled, with components mounted on suitable base.
   3. List and label engine generator assembly as complying with UL 2200.
   4. Power Factor: Unless otherwise indicated, specified power ratings are at 0.8 power factor for three phase voltages and 1.0 power factor for single phase voltages.
   5. Provide suitable guards to protect personnel from accidental contact with rotating parts, hot piping, and other potential sources of injury.
   6. Main Line Circuit Breakers: Provide factory-installed line side connections with suitable lugs for load side connections.

F. Service Conditions: Provide engine generator system and associated components suitable for operation under the service conditions at the installed location.
   1. Altitude: 1550 feet.
   2. Ambient Temperature: Between -30 and 104 degrees F.

G. Starting and Load Acceptance Requirements:
   1. Cranking Method: Cycle cranking complying with NFPA 110 (15 second crank period, followed by 15 second rest period, with cranking limiter time-out after 3 cycles), unless otherwise required.

2. Cranking Limiter Time-Out: If generator set fails to start after specified cranking period, indicate overcrank alarm condition and lock-out generator set from further cranking until manually reset.
3. Start Time: Capable of starting and achieving conditions necessary for load acceptance within 10 seconds (NFPA 110, Type 10).
4. Maximum Load Step: Supports 100 percent of rated load in one step.
    a. Maximum Voltage Deviation with Load Step: 25 percent.
    b. Maximum Frequency Deviation with Load Step: 10 percent.
5. Motor Starting Capability: Supports starting of motor load indicated with a maximum voltage dip of 30 percent.

H. Exhaust Emissions Requirements:
1. Comply with federal (EPA), state, and local regulations applicable at the time of commissioning; include factory emissions certification with submittals.
2. Do not make modifications affecting generator set factory emissions certification without approval of manufacturer and Engineer. Where such modifications are made, provide field emissions testing as necessary for certification.

I. Sound Level Requirements:
1. Do not exceed 78 dBA when measured at 23 feet from generator set in free field (no sound barriers) while operating at full load; include manufacturer's sound data with submittals.

J. Interface with building automation system via contact closure indicating "generator running" and one for "generator trouble". .

2.03 ENGINE AND ENGINE ACCESSORY EQUIPMENT

A. Provide engine with adequate horsepower to achieve specified power output at rated speed, accounting for alternator efficiency and parasitic loads.

B. Engine Fuel System - Diesel (Compression Ignition):
1. Fuel Source: Diesel, ASTM D975 No. 2-D or approved cold weather diesel blends.
2. Fuel Storage: Sub-base fuel tank.
3. Engine Fuel Supply: Provide engine-driven, positive displacement fuel pump with replaceable fuel filter(s), water separator, check valve to secure prime, manual fuel priming pump, and relief-bypass valve. Provide fuel cooler where recommended by manufacturer.
4. Engine Fuel Connections: Provide suitable, approved flexible fuel lines for coupling engine to fuel source.
5. Sub-Base Fuel Tank:
    a. Provide sub-base mounted, double-wall fuel tank with secondary containment; listed and labeled as complying with UL 142.
    b. Tank Capacity: Size for minimum of 24 hours of continuous engine generator operation at 100 percent rated load, but not larger than permissible by applicable codes.
    c. Features:
        1) Direct reading fuel level gauge.
        2) Normal atmospheric vent.
        3) Emergency pressure relief vent.
        4) Fuel fill opening with lockable cap.
        5) Dedicated electrical conduit stub-up area.
        6) Low fuel level switch.
        7) Leak detection switch; located within secondary containment interstitial space for detection of primary tank fuel leak.

C. Engine Starting System:
1. System Type: Electric, with DC solenoid-activated starting motor(s).
2. Battery(s):
    a. Battery Type: Lead-acid.
    b. Battery Capacity: Size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature; capable of providing cranking through two complete periods of cranking limiter time-outs without recharging.

c. Provide battery rack, cables, and connectors suitable for the supplied battery(s); size battery cables according to manufacturer's recommendations for cable length to be installed.

3. Battery-Charging Alternator: Engine-driven, with integral solid-state voltage regulation.
4. Battery Charger:
   a. Provide dual rate battery charger with automatic float and equalize charging modes and minimum rating of 10 amps; suitable for maintaining the supplied battery(s) at full charge without manual intervention.
   b. Capable of returning supplied battery(s) from fully discharged to fully charged condition within 24 hours, as required by NFPA 110 for Level 1 applications while carrying normal loads.
   c. Recognized as complying with UL 1236.
   d. Furnished with integral overcurrent protection; current limited to protect charger during engine cranking; reverse polarity protection.
   e. Provide integral DC output ammeter and voltmeter with five percent accuracy.
   f. Provide alarm output contacts as necessary for alarm indications.
5. Battery Heater: Provide thermostatically controlled battery heater to improve starting under cold ambient conditions.

D. Engine Speed Control System (Governor):
1. Single Engine Generator Sets (Not Operated in Parallel): Provide electronic isochronous governor for controlling engine speed/alternator frequency.
2. Generator Sets Used with Closed Transition Transfer Switches: Provide electronic isochronous governor with frequency regulation suitable for transfer.
3. Frequency Regulation, Electronic Isochronous Governors: No change in frequency from no load to full load; plus/minus 0.25 percent at steady state.

E. Engine Lubrication System:
1. System Type: Full pressure, with engine-driven, positive displacement lubrication oil pump, replaceable full-flow oil filter(s), and dip-stick for oil level indication. Provide oil cooler where recommended by manufacturer.
2. Oil Heater: Provide thermostatically controlled oil heater to improve starting under cold ambient conditions.

F. Engine Cooling System:
1. System Type: Closed-loop, liquid-cooled, with unit-mounted radiator/fan and engine-driven coolant pump; suitable for providing adequate cooling while operating at full load under worst case ambient temperature.
2. Fan Guard: Provide suitable guard to protect personnel from accidental contact with fan.
3. Ducted Radiators (Alternate Bid for Walk-in Enclosure): Where ducted radiator air discharge is to be field-installed, provide suitable radiator duct flange/adapter.
4. Coolant Heater: Provide thermostatically controlled coolant heater to improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.

G. Engine Air Intake and Exhaust System:
1. Air Intake Filtration: Provide engine-mounted, replaceable, dry element filter.
2. Engine Exhaust Connection: Provide suitable, approved flexible connector for coupling engine to exhaust system.
3. Exhaust Silencer: Provide critical grade or better exhaust silencer with sound attenuation not less than basis of design; select according to manufacturer's recommendations to meet sound performance requirements, where specified.
4. Motorized intake and exhaust louvers.

2.04 ALTERNATOR (GENERATOR)

A. Alternator: 4-pole, 1800 rpm (60 Hz output) revolving field, synchronous generator complying with NEMA MG 1; connected to engine with flexible coupling; voltage output configuration as indicated, with reconnectable leads for 3 phase alternators.

B. Exciter:

1. Exciter Type: Brushless; provide permanent magnet generator (PMG) excitation system; self-excited (shunt) systems are not permitted.
2. PMG Excitation Short-Circuit Current Support: Capable of sustaining 300 percent of rated output current for 10 seconds.
3. Voltage Regulation (with PMG excitation): Plus/minus 0.5 percent for any constant load from no load to full load.

C. Temperature Rise: Comply with UL 2200.
D. Insulation System: NEMA MG 1, Class H; suitable for alternator temperature rise.
E. Enclosure: NEMA MG 1, drip-proof.
F. Total Harmonic Distortion: Not greater than five percent.
G. Alternator Heater: Provide strip heater to prevent moisture condensation on alternator windings.

2.05 GENERATOR SET CONTROL SYSTEM

A. Provide microprocessor-based control system for automatic control, monitoring, and protection of generator set. Include sensors, wiring, and connections necessary for functions/indications specified.
B. Control Panel:
1. Control Panel Mounting: Unit-mounted unless otherwise indicated; vibration isolated.
2. Generator Set Control Functions:
a. Automatic Mode: Initiates generator set start/shutdown upon receiving corresponding signal from remote device (e.g. automatic transfer switch).
b. Manual Mode: Initiates generator set start/shutdown upon direction from operator.
c. Reset Mode: Clears all faults, allowing generator set restart after a shutdown.
d. Emergency Stop: Immediately shuts down generator set (without time delay) and prevents automatic restarting until manually reset.
e. Cycle Cranking: Programmable crank time, rest time, and number of cycles.
f. Time Delay: Programmable for shutdown (engine cooldown) and start (engine warmup).
g. Voltage Adjustment: Adjustable through range of plus/minus 5 percent.
3. Generator Set Status Indications:
a. Voltage (Volts AC): Line-to-line, line-to-neutral for each phase.
b. Current (Amps): For each phase.
c. Frequency (Hz).
d. Real power (W/kW).
e. Reactive power (VAR/kVAR).
f. Apparent power (VA/kVA).
g. Power factor.
h. Duty Level: Actual load as percentage of rated power.
i. Engine speed (RPM).
j. Battery voltage (Volts DC).
k. Engine oil pressure.
l. Engine coolant temperature.
m. Engine run time.
n. Generator powering load (position signal from transfer switch).
4. Generator Set Protection and Warning/Shutdown Indications:
a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following protections/indications:
1) Overcrank (shutdown).
2) Low coolant temperature (warning).
3) High coolant temperature (warning).
4) High coolant temperature (shutdown).
5) Low oil pressure (warning).
6) Low oil pressure (shutdown).
7) Overspeed (shutdown).
8) Low fuel level (warning).

9) Low coolant level (warning/shutdown).
10) Generator control not in automatic mode (warning).
11) High battery voltage (warning).
12) Low cranking voltage (warning).
13) Low battery voltage (warning).
14) Battery charger failure (warning).

b. In addition to NFPA 110 requirements, provide the following protections/indications:
1) High AC voltage (shutdown).
2) Low AC voltage (shutdown).
3) High frequency (shutdown).
4) Low frequency (shutdown).
5) Overcurrent (shutdown).
6) Fuel tank leak (warning), where applicable.

c. Provide contacts for local and remote common alarm.
d. Provide lamp test function that illuminates all indicator lamps.

5. Other Control Panel Features:
a. Event log.
b. Communications Capability: Compatible with system indicated. Provide all accessories necessary for proper interface.
c. Remote monitoring capability via PC.

C. Remote Annunciator:
1. Remote Annunciator Mounting: Wall-mounted; Provide flush-mounted annunciator for finished areas and surface-mounted annunciator for non-finished areas unless otherwise indicated.
2. Generator Set Status Indications:
a. Generator powering load (via position signal from transfer switch).
b. Communication functional.
3. Generator Set Warning/Shutdown Indications:
a. Comply with NFPA 110; configurable for NFPA 110 Level 1 or Level 2, or NFPA 99 systems including but not limited to the following indications:
1) Overcrank (shutdown).
2) Low coolant temperature (warning).
3) High coolant temperature (warning).
4) High coolant temperature (shutdown).
5) Low oil pressure (warning).
6) Low oil pressure (shutdown).
7) Overspeed (shutdown).
8) Low fuel level (warning).
9) Low coolant level (warning/shutdown).
10) Generator control not in automatic mode (warning).
11) High battery voltage (warning).
12) Low cranking voltage (warning).
13) Low battery voltage (warning).
14) Battery charger failure (warning).

b. Provide audible alarm with silence function.
c. Provide lamp test function that illuminates all indicator lamps.

D. Remote Emergency Stop: Provide approved red, mushroom style remote emergency stop button where indicated or required by authorities having jurisdiction.

2.06 GENERATOR SET ENCLOSURE

A. Enclosure Type: Sound attenuating, weather protective.
B. Enclosure Material: Steel or aluminum.
C. Hardware Material: Stainless steel.
D. Color: Custom color to be selected by Architect.

E. Access Doors: Lockable, with all locks keyed alike.
F. Openings: Designed to prevent bird/rodent entry.
G. External Drains: Extend oil and coolant drain lines to exterior of enclosure for maintenance service.
H. Sound Attenuating Enclosures: Line enclosure with non-hydroscopic, self-extinguishing sound-attenuating material.
I. Exhaust Silencers: Exhaust silencers shall be mounted within enclosure in main engine compartment, insulate silencer to minimize heat dissipation as necessary for operation at rated load under worst case ambient temperature.
J. Enclosure Space Heater: Provide thermostatically controlled enclosure space heater to prevent condensation and improve starting under cold ambient conditions; size according to manufacturer's recommendations for achieving starting and load acceptance requirements under worst case ambient temperature.
K. Motorized Louvers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating. Dampers shall be of a "fail open" design to allow airflow in the event of failure.
L. Provide an internally mounted and wired electrical distribution panel to serve the engine generator and enclosure; including:
    1. 100 amp distribution panelboard connected to a 120/208VAC utility service by the installer.
    2. Two duplex GFI receptacles, one inside the enclosure, and a weatherproof receptacle on the outside of the enclosure.
    3. Factory wired normal AC service from the panelboard to the engine coolant heater and battery charger.
    4. Interior Lights with Switch: Two three-way switches controlling three LED Wet Listed. Lights to be automatically shutoff by a timer.
M. Provide emergency shut-down pushbutton behind protective cover, accessble from the exterior of the enclosure.

2.07 SOURCE QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Perform production tests on generator sets at factory to verify operation and performance characteristics prior to shipment. Include certified test report with submittals.
C. Generator Set production testing to include, at a minimum:
    1. Operation at rated load and rated power factor.
    2. Single step load pick-up.
    3. Transient and steady state voltage and frequency performance.
    4. Operation of safety shutdowns.
D. Diesel Fuel Storage Tanks: Perform pressurized leak test prior to shipment.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that the ratings and configurations of generator sets and auxiliary equipment are consistent with the indicated requirements.
C. Verify that rough-ins for field connections are in the proper locations.
D. Verify that mounting surfaces are ready to receive equipment.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Install generator sets and associated accessories in accordance with NECA/EGSA 404.
D. Arrange equipment to provide minimum clearances and required maintenance access.
E. Unless otherwise indicated, mount generator set on properly sized, minimum 6 inch high concrete pad constructed in accordance with Section 03 3000.
F. Provide required support and attachment in accordance with Section 26 0529.
G. Provide required vibration isolation and/or seismic controls in accordance with Section 26 0548.
H. Use manufacturer's recommended oil and coolant, suitable for the worst case ambient temperatures.
I. Provide diesel fuel piping and venting in accordance with Section 23 1113, where not factory installed.

J. Provide engine exhaust piping in accordance with Section 23 5100, where not factory installed.
   1. Include piping expansion joints, piping insulation, thimble, condensation trap/drain, rain cap, hangers/supports, etc. as indicated or as required.
   2. Do not exceed manufacturer's maximum back pressure requirements.
K. Install exhaust silencer in accordance with Section 23 5100, where not factory installed.
L. Provide grounding and bonding in accordance with Section 26 0526.
M. Identify system wiring and components in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Provide services of a manufacturer's authorized representative to prepare and start systems and perform inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.
C. Notify Owner and Engineer at least two weeks prior to scheduled inspections and tests.
D. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
E. Provide all equipment, tools, and supplies required to accomplish inspection and testing, including load bank and fuel.
F. Preliminary inspection and testing to include, at a minimum:
   1. Inspect each system component for damage and defects.
   2. Verify tightness of mechanical and electrical connections are according to manufacturer's recommended torque settings.
   3. Check for proper oil and coolant levels.
G. Prepare and start system in accordance with manufacturer's instructions.
H. Perform acceptance test in accordance with NFPA 110.
I. Inspection and testing to include, at a minimum:
   1. Verify compliance with starting and load acceptance requirements.
   2. Verify voltage and frequency; make required adjustments as necessary.
   3. Verify phase sequence.
   4. Verify control system operation, including safety shutdowns.
   5. Verify operation of auxiliary equipment and accessories (e.g. battery charger, heaters, etc.).
   6. Perform load tests in accordance with NFPA 110 (1.5 hour building load test followed by 2 hour full load test).
J. Provide field emissions testing where necessary for certification.
K. Sound Level Tests: Measure sound levels for compliance with specified requirements. Identify and report ambient noise conditions.
L. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
M. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
B. See Section 01 7900 - Demonstration and Training, for additional requirements.
C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
D. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum (2) four hours training sessions on two different days.
   3. Instructor: Manufacturer's authorized representative.
   4. Location: At project site.

E. After successful acceptance test and just prior to Substantial Completion, replace air, oil, and fuel filters and fill fuel storage tank.

3.06 PROTECTION

A. Protect installed engine generator system from subsequent construction operations.

END OF SECTION

SECTION 26 3600 - TRANSFER SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Transfer switches for low-voltage (600 V and less) applications and associated accessories:
   1. Automatic transfer switches.
   2. Non-automatic transfer switches.
   3. Manual transfer switches.
   4. Includes bypass/isolation transfer switches.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
C. Section 26 0529 - Hangers and Supports for Electrical Systems.
D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
E. Section 26 0573 - Power System Studies: Additional criteria for the selection of equipment specified in this section.
F. Section 26 3213 - Engine Generators: For interface with transfer switches.
   1. Includes code requirements applicable to work of this section.
   2. Includes additional testing requirements.
   3. Includes related demonstration and training requirements.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
C. NEMA ICS 10 Part 1 - Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment; 2005.
D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. NFPA 99 - Health Care Facilities Code; 2015.
G. NFPA 110 - Standard for Emergency and Standby Power Systems; 2016.
H. UL 1008 - Transfer Switch Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate compatibility of transfer switches to be installed with work provided under other sections or by others.
      a. Engine Generators: See Section 26 3213.
   2. 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.
   3. Coordinate arrangement of equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   4. Coordinate the work with placement of supports, anchors, etc. required for mounting.
   5. Closed Transition Transfer Switches:
      a. Coordinate source interconnection requirements with Utility Company.
      b. Where applicable, coordinate the work to provide engine generators with isochronous governors suitable for closed transition transfer.
      c. Coordinate the work to provide shunt trip breakers necessary for protection from source interconnection for longer than specified maximum interconnection time.
      d. Arrange for inspections necessary to obtain Utility Company approval of installation.
   6. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
B. Preinstallation Meeting: Convene one week before starting work of this section; require attendance of all affected installers.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product, including ratings, configurations, dimensions, finishes, weights, service condition requirements, and installed features.

C. Shop Drawings: Include dimensioned plan views and sections indicating locations of system components, required clearances, and field connection locations. Include system interconnection schematic diagrams showing all factory and field connections.

1. Clearly indicate whether proposed short circuit current ratings are based on testing with specific overcurrent protective devices or time durations; indicate short-time ratings where applicable.

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 operation of product.

E. Manufacturer’s detailed field testing procedures.

F. Field quality control test reports.

G. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

H. Maintenance contracts.

I. Project Record Documents: Record actual locations of system components, installed circuiting arrangements and routing, and final equipment settings.

1.06 QUALITY ASSURANCE

A. Comply with the following:

1. NFPA 70 (National Electrical Code).
2. NFPA 110 (Standard for Emergency and Standby Power Systems); meet requirements for system Level specified in Section 26 3213.
3. NFPA 99 (Health Care Facilities Code).

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

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

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

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store transfer switches in accordance with manufacturer's instructions.

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 instructions to avoid damage to transfer switch components, enclosure, and finish.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Transfer Switches - Basis of Design: ASCO Power Technologies.

B. Transfer Switches - Other Acceptable Manufacturers:

1. ASCO Power Technologies: www.ascopower.com/#sle.
2. Same as manufacturer of engine generator(s) used for this project.

C. Substitutions: See Section 01 6000 - Product Requirements.

D. Products other than basis of design are subject to compliance with specified requirements. By using products other than basis of design, Contractor accepts responsibility for costs associated with any necessary modifications to related work, including any design fees.

2.02 TRANSFER SWITCHES

A. Provide complete power transfer system consisting of all required equipment, conduit, boxes, wiring, supports, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Applications:
   1. Utilize closed transition transfer unless otherwise indicated or required.
   2. Neutral Switching (Single Phase, Three Wire and Three Phase, Four Wire Systems):
      a. Unless otherwise indicated or required, provide neutral switching:
         1) For systems with ground fault protection.
         2) Where the alternate/emergency source is a separately derived system.

D. Construction Type: Only "contactor type" (open contact) transfer switches are acceptable. Do not use "breaker type" (enclosed contact) transfer switches. Breaker type transfer switches shall be acceptable for the manual transfer switch provided as the "temporary generator connection cabinet."

E. Automatic Transfer Switch:
   1. Transfer Switch Type: Automatic transfer switch.
   2. Transition Configuration: Closed-transition.
   3. Voltage: 480/277V.
   4. Ampere Rating: As indicated on the drawings.
   5. Neutral Configuration: Switched neutral.
   6. Primary Source: Utility (fed from circuit indicated on Drawings).
   7. Alternate Source: Engine generator (fed from circuit indicated on Drawings).

F. Manual Transfer Switch: (Temporary Generator Connection Cabinet)
   1. Voltage: As indicated on the drawings.
   2. Ampere Rating: As indicated on the drawings.
   3. Neutral Configuration: Solid neutral (unswitched), except as indicated.
   4. Load Served: As indicated on the drawings.
   5. Primary Source: As indicated on the drawings.
   6. Alternate Source: As indicated on the drawings.
   7. Features:
      a. Cam lock connection terminals for temporary generator connection (ampacity as indicated on Drawings).
   8. Product(s):
      a. ASCO 300 series.

G. Comply with NEMA ICS 10 Part 1, and list and label as complying with UL 1008 for the classification of the intended application (e.g. emergency, optional standby).

H. Do not use double throw safety switches or other equipment not specifically designed for power transfer applications and listed as transfer switch equipment.

I. Load Classification: Classified for total system load (any combination of motor, electric discharge lamp, resistive, and tungsten lamp loads with tungsten lamp loads not exceeding 30 percent of the continuous current rating) unless otherwise indicated or required.

J. Switching Methods:
   1. Open Transition: (Temporary Generator Connection Cabinet only)
      a. Provide break-before-make transfer without a neutral position that is not connected to either source, and with interlocks to prevent simultaneous connection of the load to both sources.
   2. Closed Transition:
      a. When both sources are available and synchronized, provide make-before-break transfer without interruption of power to the load and with momentary interconnection of both sources for not more than 100 ms, unless otherwise approved by Utility Company.
      b. Provide synchronization/in-phase monitor to initiate transfer when voltage and phase angle difference between sources are within predetermined requirements for synchronization.

c. Source Synchronization Requirements: Phase angle differential within five degrees; voltage differential within five volts.
d. When sources fail to synchronize within a predetermined time period, remain connected to current source and initiate an alarm.
e. When sources remain interconnected for longer than specified maximum interconnection time, provide contact closure signal to shunt trip designated circuit breaker and initiate an alarm.
f. Provide additional protective relaying where required by Utility Company.
g. When only one source is available, automatically utilizes open transition (break-before-make) transfer.

3. Neutral Switching: Either simultaneously switched neutral (break-before-make) or overlapping neutral (make-before-break) methods are acceptable.
4. Obtain control power for transfer operation from line side of source to which the load is to be transferred.

K. Service Conditions: Provide transfer switches suitable for continuous operation at indicated ratings under the service conditions at the installed location.

L. Enclosures:
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
a. Indoor Clean, Dry Locations: Type 1 or Type 12.
b. Outdoor Locations: Type 3R or Type 4.
2. Provide lockable door(s) for outdoor locations.
3. Finish: Manufacturer's standard unless otherwise indicated.

M. Short Circuit Current Rating:
1. Withstand and Closing Rating: Provide transfer switches, when protected by the supply side overcurrent protective devices to be installed, with listed withstand and closing rating not less than the available fault current at the installed location as determined by short circuit study performed in accordance with Section 26 0573.
2. Short Time Rating: Where the requirement for selectivity is indicated, provide transfer switches with short time ratings suitable for the maximum short time delay setting of the supply side overcurrent protective device.

N. Automatic Transfer Switches:
1. Description: Transfer switches with automatically initiated transfer between sources; electrically operated and mechanically held.
2. Control Functions:
a. Automatic mode.
b. Test Mode: Simulates failure of primary/normal source.
c. Voltage and Frequency Sensing:
1) Undervoltage sensing for each phase of primary/normal source; adjustable dropout/pickup settings.
2) Undervoltage sensing for alternate/emergency source; adjustable dropout/pickup settings.
3) Underfrequency sensing for alternate/emergency source; adjustable dropout/pickup settings.
d. Outputs:
1) Contacts for engine start/shutdown (except where direct generator communication interface is provided).
2) Auxiliary contacts; one set(s) for each switch position.
e. Adjustable Time Delays:
1) Engine generator start time delay; delays engine start signal to override momentary primary/normal source failures.
2) Transfer to alternate/emergency source time delay.
3) Retransfer to primary/normal source time delay.
4) Engine generator cooldown time delay; delays engine shutdown following retransfer to primary/normal source to permit generator to run unloaded for cooldown period.

f. In-Phase Monitor (Open Transition Transfer Switches): Monitors phase angle difference between sources for initiating in-phase transfer.
g. Synchronization/In-Phase Monitor (Closed Transition Transfer Switches): Monitors voltage and phase angle difference between sources for initiating synchronized transfer.
h. Engine Exerciser: Provides programmable scheduled exercising of engine generator selectable with or without transfer to load; provides memory retention during power outage.

3. Status Indications:
   a. Connected to alternate/emergency source.
   b. Connected to primary/normal source.
   c. Alternate/emergency source available.
4. Alarm Indications for Closed Transition Transfer Switches:
   a. Failure to synchronize.
   b. Extended source interconnection/transfer switch locked out.
5. Other Features:
   a. Remote monitoring capability via PC.
6. Automatic Sequence of Operations:
   a. Upon failure of primary/normal source for a programmable time period (engine generator start time delay), initiate starting of engine generator where applicable.
   b. When alternate/emergency source is available, transfer load to alternate/emergency source after programmable time delay.
   c. When primary/normal source has been restored, retransfer to primary/normal source after a programmable time delay. Bypass time delay if alternate/emergency source fails and primary/normal source is available.
   d. Where applicable, initiate shutdown of engine generator after programmable engine cooldown time delay.

O. Non-Automatic Transfer Switches:
   a. Manual source selection.
   b. Outputs:
      1) Auxiliary contacts; one set for each switch position.
   c. Connected to alternate/emergency source.
   d. Connected to primary/normal source.
   e. Alternate/emergency source available.

P. Manual Transfer Switches:
   1. Description: Transfer switches with manually initiated transfer between sources; mechanically operated and mechanically held.

Q. Bypass/Isolation Transfer Switches:
   1. Description: Factory-assembled units consisting of interconnected transfer switch and bypass/isolation switch that permits manual bypass and isolation of the transfer switch with connection of the load to either source.
   2. Bypass/Isolation Switch Type: Provide overlapping (make-before-break) switches with no interruption of power to load. Load break (break-before-make) switches that interrupt power to load are not acceptable.
   3. Bypass/Isolation Operation:
      a. Operable from exterior of enclosure.
      b. Normal Mode: Provides for normal operation of transfer switch.
      c. Test Mode: Provides for operational testing of bypassed transfer switch without affecting power to load.
      d. Isolate Mode: Provides for complete isolation of transfer switch from all power sources, permitting removal from unit.

R. Interface with Other Work:
   1. Interface with engine generators as specified in Section 26 3213.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that the ratings and configurations of transfer switches are consistent with the indicated requirements.
C. Verify that rough-ins for field connections are in the proper locations.
D. Verify that mounting surfaces are ready to receive transfer switches.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Arrange equipment to provide minimum clearances and required maintenance access.
D. Provide required support and attachment in accordance with Section 26 0529.
E. Install transfer switches plumb and level.
F. Unless otherwise indicated, mount floor-mounted transfer switches on properly sized 3 inch high concrete pad constructed in accordance with Section 03 3000.
G. Provide grounding and bonding in accordance with Section 26 0526.
H. Identify transfer switches and associated system wiring in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Prepare and start system in accordance with manufacturer's instructions.
C. Automatic Transfer Switches:
    1. Inspect and test in accordance with NETA ATS, except Section 4.
    2. Perform inspections and tests listed in NETA ATS, Section 7.22.3. The insulation-resistance tests listed as optional are not required.
D. Provide additional inspection and testing as required for completion of associated engine generator testing as specified in Section 26 3213.
E. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
B. See Section 01 7900 - Demonstration and Training, for additional requirements.
C. Demonstration: Demonstrate proper operation of transfer switches to Owner, and correct deficiencies or make adjustments as directed.
D. Training: Train Owner's personnel on operation, adjustment, and maintenance of transfer switches.
    1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
    2. Provide minimum of four hours of training.
    3. Instructor: Manufacturer's authorized representative.
    4. Location: At project site.
E. Coordinate with related generator demonstration and training as specified in Section 26 3213.

3.06 PROTECTION

A. Protect installed transfer switches from subsequent construction operations.

3.07 MAINTENANCE

A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
B. Provide to Owner a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of transfer switches for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, inspection, and testing, with a

detailed schedule.

C. Provide trouble call-back service upon notification by Owner:
   1. Provide on-site response within 4 hours of notification.
   2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
   3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
D. Maintain an on-site log listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced.

END OF SECTION

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SECTION 26 4113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Strike (air) terminals and interconnecting conductors.

B. Grounding and bonding for lightning protection.

1.02 REFERENCE STANDARDS

A. NFPA 780 - Standard for the Installation of Lightning Protection Systems; 2017.

B. UL 96 - Lightning Protection Components; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination with Concrete Work: Coordinate the embedding of lightning protection components in concrete.

B. Coordination with Roofing Work: Ensure adequate attachment of strike terminals and conductors without damage to roofing.

C. Preinstallation Meeting: Convene a meeting at least at least two weeks prior to commencement of any work affected by lightning protection system requirements to discuss prerequisites and coordination required by other installers; require attendance by representatives of installers whose work will be affected.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate location and layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details.

1. Where conductors or grounds are to be embedded or concealed in other construction, submit shop drawings at least 30 days prior to start of construction.
2. If concrete-encased grounds are to be used and are not shown in Contract Documents, provide sufficient data to determine concrete encasement dimensions and location.
3. Include data on actual ground resistance determined by field measurement in accordance with NFPA 780.
4. Include engineering analysis of equalization of potential to metal bodies within the structure.
5. Include access panels, test holes, and disconnecting means for maintenance.

C. Product Data: Provide dimensions and materials of each component, indication of testing agency listing, and installation instructions.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Installation Certification: Submit copy of certification agency's approval.

F. Operation and Maintenance Data: Provide recommended inspection and testing plan, including recommended intervals, to achieve periodic maintenance as recommended in NFPA 780; provide customized plan reflecting actual installation configuration with specific installed components identified.

G. Project Record Documents: Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors in project record documents.

1.05 QUALITY ASSURANCE

A. Maintain one copy of each referenced system design standard on site.

B. Designer Qualifications: Person or entity, employed by installer, who specializes in lightning protection system design with minimum three years documented experience.

C. Installer Qualifications: Company specializing in lightning protection system design with minimum three years documented experience.

D. Field Quality Control Testing Agency Qualifications: Firm capable of and experienced in grounding and bonding testing with documented experience and minimum of three project references.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Lightning Protection Components:

1. Advanced Lightning Technology (ALT): www.altfab.com/#sle.
2. Harger Lightning and Grounding: www.harger.com/#sle.
3. National Lightning Protection Corporation: www.theprotectionsource.com/#sle.
4. Substitutions: See Section 01 6000 - Product Requirements.

2.02 LIGHTNING PROTECTION SYSTEM

A. Lightning Protection System: Provide complete system complying with NFPA 780, including air terminals, bonding, interconnecting conductors and grounding electrodes.
   1. Provide system that protects:
      a. The entire structure.
      b. Open air areas within 100 feet of exterior walls at grade level.
      c. Open air areas within building footprint.
      d. Engine generator enclosure on grade adjacent to structure..
   2. Coordinate with other grounding and bonding systems specified.
   3. Determine ground resistance by field measurement.
   4. Provide copper, bronze, or stainless steel components, as applicable; no aluminum.
   5. Provide copper, bronze, or stainless steel components, except where aluminum is allowed by NFPA 780.
   6. Provide disconnecting means and access panels or similar devices to allow complete periodic inspection and testing as described by NFPA 780 Annex D.
   7. Provide system certified by Underwriters Laboratories or the Lightning Protection Institute.

B. Strike Terminals: Provide strike (air) terminals on the following:
   1. Roofs.
   2. Parapets.
   3. Roof mounted equipment.
   4. Stacks.
   5. Chimneys.

2.03 COMPONENTS

A. All Components: Complying with applicable requirements of UL 96.
B. Strike (Air) Terminals: Copper, solid, with adhesive bases for single-ply roof installations.
C. Grounding Rods: Solid copper.
D. Ground Plate: Copper.
E. Conductors: Copper cable.
F. Connectors and Splicers: Bronze.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated on shop drawings.
B. Coordinate work with installation of roofing and exterior and interior finishes.

3.02 INSTALLATION

A. Install in accordance with referenced system standards and as required for specified certification.
B. Connect conductors using mechanical connectors or exothermic welding process; protect adjacent construction elements and finishes from damage.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Perform visual inspection as specified in NFPA 780 as if this were a periodic follow-up inspection.
C. Perform continuity testing as specified in NFPA 780 as if this were testing for periodic maintenance.
D. Obtain the services of the specified certification agency to provide inspection and certification of the lightning protection system, including performance of any other testing required by that agency.

END OF SECTION

SECTION 26 4300 - SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surge protective devices for service entrance locations.
B. Surge protective devices for distribution locations.
C. Surge protective devices for distribution panelboard locations.

1.02 ABBREVIATIONS AND ACRONYMS

A. EMI/RFI: Electromagnetic Interference/Radio Frequency Interference.
B. SPD: Surge Protective Device.

1.03 REFERENCE STANDARDS

A. MIL-STD-220 - Method of Insertion Loss Measurement; Revision C, 2009.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. UL 1283 - Standard for Electromagnetic Interference Filters; Current Edition, Including All Revisions.
G. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate size and location of overcurrent device compatible with the actual surge protective device and location to be installed. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to ordering equipment.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Include detailed component information, voltage, surge current ratings, repetitive surge current capacity, voltage protection rating (VPR) for all protection modes, maximum continuous operating voltage (MCOV), nominal discharge current (I-n), short circuit current rating (SCCR), connection means including any required external overcurrent protection, enclosure ratings, outline and support point dimensions, weight, service condition requirements, and installed features.
C. Shop Drawings: Include wiring diagrams showing all factory and field connections with wire and circuit breaker/fuse sizes.
D. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
E. Project Record Documents: Record actual connections and locations of surge protective devices.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in accordance with manufacturer's written instructions.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Manufacturer's Warranty: Provide minimum five year warranty covering repair or replacement of surge protective devices showing evidence of failure due to defective materials or workmanship.
C. Exclude surge protective devices from any clause limiting warranty responsibility for acts of nature, including lightning, stated elsewhere.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Field-installed, Externally Mounted Surge Protective Devices - Other Acceptable Manufacturers:
    1. ABB/GE: www.geindustrial.com/#sle.
    2. Advanced Protection Technologies, Inc (APT): www.aptsurge.com/#sle.
    3. Current Technology; a brand of Thomas & Betts Power Solutions: www.tnbpowersolutions.com/#sle.

4. Schneider Electric; Square D Brand Surgelogic Products: www.surgelogic.com/#sle.
5. Surge Suppression, LLC (SSI): www.surgesuppression.com/#sle.
6. Total Protection Solutions.

B. Factory-installed, Internally Mounted Surge Protective Devices:
1. Same as manufacturer of equipment containing surge protective device, to provide a complete listed assembly including SPD.

C. Substitutions: See Section 01 6000 - Product Requirements.

2.02 SURGE PROTECTIVE DEVICES - GENERAL REQUIREMENTS

A. Description: Factory-assembled surge protective devices (SPDs) for 60 Hz service; listed, classified, and labeled as suitable for the purpose intended; system voltage as indicated on the drawings.

B. Unless otherwise indicated, provide field-installed, externally-mounted or factory-installed, internally-mouonted SPDs.

C. List and label as complying with UL 1449, Type 1 when connected on line side of service disconnect overcurrent device and Type 1 or 2 when connected on load side of service disconnect overcurrent device.

D. Protected Modes:
1. Wye Systems: L-N, L-G, N-G, L-L.

E. UL 1449 Voltage Protection Ratings (VPRs):
1. 208Y/120V System Voltage: Not more than 1,000 V for L-N, L-G, and N-G modes and 1,200 V for L-L mode.
2. 480Y/277V System Voltage: Not more than 1,500 V for L-N, L-G, and N-G modes and 2,000 V for L-L mode.

F. UL 1449 Maximum Continuous Operating Voltage (MCOV): Not less than 115% of nominal system voltage.

G. Enclosure Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
1. Indoor clean, dry locations: Type 1.
2. Outdoor locations: Type 3R.

H. Mounting for Field-installed, Externally Mounted SPDs: Unless otherwise indicated, as specified for the following locations:
1. Provide surface-mounted SPD where mounted in non-public areas or adjacent to surface-mounted equipment.
2. Provide flush-mounted SPD where mounted in public areas or adjacent to flush-mounted equipment.

2.03 SURGE PROTECTIVE DEVICES FOR SERVICE ENTRANCE LOCATIONS

A. Surge Protective Device:
1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 120 kA per mode/240 kA per phase.
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
a. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.
6. Diagnostics:
a. Protection Status Monitoring: Provide indicator lights to report the protection for each phase.
b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.
c. Remote Status Monitoring: Provide Form C dry type contacts (normally open and normally closed) for remote annunciation of status.

2.04 SURGE PROTECTIVE DEVICES FOR DISTRIBUTION LOCATIONS

A. Distribution locations include SPDs connected to distribution panelboards and busway.

B. Surge Protective Device:
1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 80 kA per mode/160 kA per phase.

3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
    a. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.
6. Diagnostics:
    a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
    b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.

2.05 SURGE PROTECTIVE DEVICES FOR BRANCH PANELBOARD LOCATIONS

A. Surge Protective Device:
1. Protection Circuits: Field-replaceable modular or non-modular.
2. Surge Current Rating: Not less than 60 kA per mode/120 kA per phase.
3. UL 1449 Nominal Discharge Current (I-n): 20 kA.
4. UL 1449 Short Circuit Current Rating (SCCR): Not less than the available fault current at the installed location as indicated on the drawings.
5. EMI/RFI Filtering: Provide EMI/RFI filter to attenuate electrical noise; listed as complying with UL 1283 for Type 2 SPDs (UL 1283 listing not available for Type 1 SPDs).
    a. Noise Attenuation: Not less than 40 dB at 100 kHz using MIL-STD-220 insertion loss test method.
6. Diagnostics:
    a. Protection Status Monitoring: Provide indicator lights to report the protection status for each phase.
    b. Alarm Notification: Provide indicator light and audible alarm to report alarm condition. Provide button to manually silence audible alarm.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that the service voltage and configuration marked on the SPD are consistent with the service voltage and configuration at the location to be installed.
C. Verify that electrical equipment is ready to accept connection of the SPD and that installed overcurrent device is consistent with requirements of drawings and manufacturer's instructions.
D. Verify system grounding and bonding is in accordance with Section 26 0526, including bonding of neutral and ground for service entrance and separately derived systems where applicable. Do not energize SPD until deficiencies have been corrected.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
D. Unless indicated otherwise, connect service entrance surge protective device on load side of service disconnect main overcurrent device.
E. Provide conductors with minimum ampacity as indicated on the drawings, as required by NFPA 70, and not less than manufacturer's recommended minimum conductor size.
F. Install conductors between SPD and equipment terminations as short and straight as possible, not exceeding manufacturer's recommended maximum conductor length. Breaker locations may be reasonably rearranged in order to provide leads as short and straight as possible. Twist conductors together to reduce inductance.
G. Do not energize SPD until bonding of neutral and ground for service entrance and separately derived systems is complete in accordance with Section 26 0526 where applicable. Replace SPDs damaged by improper or missing neutral-ground bond.

H. Disconnect SPD prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPD connected.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS Section 7.19.1.

3.04 CLEANING

A. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION

SECTION 26 5100 - INTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior luminaires.
B. Emergency lighting units.
C. Exit signs.
D. Drivers.

1.02 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.
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; 2015.
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.

1.03 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.

1.04 SUBMITTALS

A. See Section 01 3000 - 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.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.06 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.

1.07 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

2.02 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. LED Tape Lighting Systems: Provide all power supplies, drivers, cables, connectors, channels, covers, mounting accessories, and interfaces as necessary to complete installation.
   1. LED Tape - General Requirements:
      a. Listed.
      b. Designed for field cutting in accordance with listing.

K. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.03 EMERGENCY LIGHTING UNITS

A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.

B. 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.

C. Battery:
   1. Size battery to supply all connected lamps, including emergency remote heads where indicated.

D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

E. Provide low-voltage disconnect to prevent battery damage from deep discharge.

2.04 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.

2.05 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 five 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 .90.
   5. Driver includes TVSS.
   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.
      a. Wall Dimmers: See Section 26 2726.

PART 3 EXECUTION

3.01 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.

3.02 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.

3.03 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 0533.16 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 0529.

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. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet between supports.
4. Install canopies tight to mounting surface.
5. 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. Emergency Lighting Units:
1. Unless otherwise indicated, connect unit to unswitched power from circuit indicated. Bypass local switches, contactors, or other lighting controls.
2. Install lock-on device on branch circuit breaker serving units.

N. Exit Signs:
1. Unless otherwise indicated, connect unit to unswitched power from circuit indicated. Bypass local switches, contactors, or other lighting controls.
2. Install lock-on device on branch circuit breaker serving units.

O. Install lamps in each luminaire.

3.04 FIELD QUALITY CONTROL

A. See Section 01 4000 - 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.

3.05 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.

3.06 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.

3.07 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

B. See Section 01 7900 - Demonstration and Training, for additional requirements.

3.08 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

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SECTION 26 5600 - EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Exterior luminaires.

B. Poles and accessories.

1.02 REFERENCE STANDARDS

A. AASHTO LTS - Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals; 2013, with Editorial Revision (2022).

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.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

E. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems; 2000 (Reaffirmed 2006).

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.

1.03 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.

1.04 SUBMITTALS

A. See Section 01 3000 - 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.

D. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.

1.05 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.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

2.02 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. 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.

2.03 POLES

A. All Poles:
    1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.
    2. Structural Design Criteria:
        a. Comply with AASHTO LTS.
        b. Wind Load: Include effective projected area (EPA) of luminaire(s) and associated supports and accessories to be installed.
    3. Material: Steel, unless otherwise indicated.
    4. Shape: Round straight, unless otherwise indicated.
    5. Finish: Match luminaire finish, unless otherwise indicated.
    6. Mounting: Install on concrete foundation, height as indicated on the drawings, unless otherwise indicated.
    7. Unless otherwise indicated, provide with the following features/accessories:
        a. Top cap.
        b. Handhole.
        c. Anchor bolts with leveling nuts or leveling shims.
        d. Anchor base cover.

PART 3 EXECUTION

3.01 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.

3.02 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.

3.03 INSTALLATION

A. Coordinate locations of outlet boxes provided under Section 26 0533.16 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 0529.
E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
F. Install accessories furnished with each luminaire.
G. Bond products and metal accessories to branch circuit equipment grounding conductor.
H. Install lamps in each luminaire.

3.04 FIELD QUALITY CONTROL

A. See Section 01 4000 - 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.

3.05 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.

3.06 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.

3.07 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

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SECTION 27 1000 - STRUCTURED CABLING

PART 1 GENERAL

1.01 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 grounding and bonding.
G. Communications identification.

1.02 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. ICEA S-90-661 - Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables (With or Without An Overall Shield) For Use in General Purpose and LAN Communications Wiring Systems Technical Requirements; 2012.
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
E. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2016.
F. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards; 2009c, with Addendum (2016).
G. TIA-568.3 - Optical Fiber Cabling and Components Standard; 2016d.
H. TIA-598 - Optical Fiber Cable Color Coding; 2014d.
I. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2017c.
J. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2015c, with Addendum (2017).
K. UL 444 - Communications Cables; Current Edition, Including All Revisions.
L. UL 514C - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.
M. UL 1651 - Fiber Optic Cable; Current Edition, Including All Revisions.
N. UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.

1.03 DEFINITIONS / TERMS / ACRONYMS

A. Acronyms
    1. ANSI - American Northern Standards Institute
    2. AWG - American Wire Gauge
    3. BC - Bare Copper
    4. BICSI - Building Industry Consulting Service International
    5. CCS - Copper Clad Steel
    6. CEA - Consumer Electronics Association
    7. EIA - Electronics Industry Alliance - Ceased Operation Feb. 2011
    8. IEC - International Electrotechnical Commission
    9. IEEE - Institute of Electrical and Electronic Engineers
    10. LAN: Local area network
    11. NECA - National Electrical Contractors Association
    12. NFPA - National Fire Protection Agency
    13. RCDD: Registered Communications Distribution Designer.
    14. TIA - Telecommunications Industry Association
    15. UL - Underwriters Laboratory
B. Terms / Definitions (See also Section 26 0000)
    1. Backbone: A facility (e.g., pathway, cable or conductors) between telecommunications rooms, or floor distribution terminals, the entrance facilities and equipment rooms within or between buildings.

2. Backbone Cabling: Cabling and connecting hardware that provides interconnections between telecommunications rooms, equipment rooms, and entrance facilities.
3. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails
4. Building Distribution Frame (BDF): Centrally located support structure for terminating horizontal cables that extend to telecommunications outlets, functioning as point of connection / demarcation for the cabling of that building to the campus Main Distribution Frame.
5. Cabling: The term “cabling” will mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.
6. Horizontal Cabling: The cabling between and including the work area outlet/connector and the horizontal cross-connect/patch cord in the telecommunications room. Wired in star topology to distribution frame located at center hub of star; also referred to as "links".
7. Intermediate Distribution Frames (IDF): Centrally located support structure for terminating horizontal cables that extend to telecommunications outlets and for terminating backbone cabling that extends to the Building Distribution Frame.
8. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
9. Main Distribution Frame (MDF): Centrally located support structure for terminating horizontal cables that extend to telecommunications outlets, functioning as point of demarcation to external service provider.
10. Permanent Link: Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
11. Pull Point: A Pull Point is a space used to transition between floors for backbone and horizontal cabling within a building riser system.
12. Telecommunications: A branch of technology concerned with the transmission, emission, and reception of signs, signals, writing, images, and sounds; that is, information, of any nature by cable, radio, optical, or other electromagnetic systems

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate disruptions in service with NDSU.
   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.
B. Preinstallation Meeting: Convene a minimum of one week prior to commencing work of this section to review service requirements and details with NDSU Facilities Management representative. Contractor shall have the cabling project manager and installation foreman present for this meeting. Additionally, a representative from the General Contractor's project management team and electrical contractor shall be in attendance when this scope of work is performed under a subcontract to either party.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
C. Shop Drawings: Provide drawings with elevations of equipment racks and cabinets, cable routes, cable tray routes, rack and enclosure locations (dimensioned form walls), exterior cabling routes, grounding system one-line diagram, drawings showing locations of grounding componetnts. Drawings shall be prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
D. Field Test Reports.
E. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
   1. Record actual locations of outlet boxes and distribution frames.

2. Record acutal routes of backbone cabling.
3. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
4. Identify distribution frames and equipment rooms by room number on drawings.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: At least 3 years' experience manufacturing products of the type specified.
B. Installer Qualifications: A company having at least 3 years' experience in the installation and testing of the type of system specified, and:
   1. Employing a BICSI Registered Communications Distribution Designer (RCDD).
   2. On site foreman shall possess a current BICSI Installer 2 certification, and all installers shall possess a current Panduit installer certification.
   3. Employing experienced technicians for all work; show at least 3 years' experience in the installation of the type of system specified, with evidence from at least 2 projects that have been in use for at least 18 months; submit project name, address, and written certification by user.
C. Products: Listed, classified, and labeled as suitable for the purpose intended.
D. Source Limitations: Obtain units of the same type of equipment through one source from a single manufacturer.
E. Telecommunications Pathways and Spaces: Comply with ANSI/TIA-568-C.
F. Coordination:
   1. Contractor shall coordinate with the Owner's network and computer equipment personnel for specific instructions before starting Work.
   2. Contractor shall coordinate with the General Contractor for location and type of blocking to be installed in the walls to support wall mounted equipment.
   3. Contractor shall coordinate location of electrical receptacles to be installed on raceways, racks or inside cabinets.
G. Comply with the requirements of the utility companies.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
B. Correct defective Work within a 1 year period after Date of Substantial Completion.
C. Manufacturer shall warranty and provide maintenance service for 15 years minimum on the network system and a lifetime for products used in the system.

1.08 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. 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.
D. 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.
E. Handle in accordance with NEMA and the Manufacturer's recommendations and instructions to avoid damaging equipment, installed devices and finish.
F. 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

2.01 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 (cabling) and TIA-569 (pathways), latest editions (commercial standards).

2. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, non condensing.

B. New backbone cabling shall be installed from Dolve to the Intermediate Distribution Frame rooms identified on the Drawings.
C. New horizontal cabling shall be installed from the Intermediate Distribution Frame rooms to the outlets.
D. Patch cords shall be installed at the equipment racks.
E. Contractor shall set, wire, and connect Owner furnished Wireless Access Points and mounting hardware.
F. 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.
G. 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.

2.02 PATHWAYS

A. Conduit: As specified in Section 26 0533.13; provide pull cords in all conduit.
1. From outlet boxes to accessible ceiling minimum size shall be 1".

B. Outlet boxes: Minmimum size 4-11/16" square x 2-1/8" deep with single gang ring unless noted otherwise.
C. Cable Trays: As specified in Section 26 0536.
D. Underground Service Entrance: Rigid polyvinyl chloride (PVC) conduit, Schedule 40.

2.03 COPPER CABLE AND TERMINATIONS

A. Copper Backbone Cable:
1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2, ICEA S-90-661, and listed and labeled as complying with UL 444; arranged in 25-pair binder groups.
2. Cable Type: Superior Essex Group SEALPIC-F (RUS PE39) water resistant with overall aluminum shield.
   a. 24 AWG, non-shielded, copper conductors.
   b. ETPR compound filling with polyethylene jacket.
   c. Color Code: Standard telephone industry specifications,
3. Cable Capacity: Quantity of pairs as indicated on drawings.
4. Cable Applications:
   a. Plenum Applications: Use listed NFPA 70 Type CMP plenum cable.
5. Product(s):
   a. General
   b. Commscope
   c. Essex Group
   d. Substitutions according to provisions of Section - Electrical General Requirements

B. 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 6A UTP (unshielded twisted pair); 23 AWG, 100 ohm, 4 individually twisted pairs; complying with all relevant parts of and addenda to latest edition of TIA/EIA-568 and UL 444.
3. Cable Type - Wireless Access Point: TIA-568.2 Category 6A UTP (unshielded twisted pair); 23 AWG, 100 ohm, 4 individually twisted pairs; complying with all relevant parts of and addenda to latest edition of TIA/EIA-568 and UL 444.
4. Cable Type - Installed in underground conduit (including within building): GenSpeed 10 UTP indoor/outdoor plenum cat 6A rated cable or equal.
5. Cable Capacity: 4-pair.
6. Cable Applications: Use listed NFPA 70 Type CMP plenum cable unless otherwise indicated.
7. Cable Jacket Color -.
   a. Data, Telephone, Wireless Access Points: Blue
   b. Surveillance Cameras: Yellow

c. Lighting Controls: Green

8. Product(s): Unless noted otherwise.
   a. CommScope; Uniprise Twisted Pair Cables: www.commscope.com/#sle. Ultra 10 Seires.
   b. General Cable Technologies Corporation; GenSPEED Cables: GenSPEED 10 MTP Category 6A Cable : www.generalcable.com/#sle.
   c. Berk Tek LANmark 10G2 series.
   d. Panduit NUL6X series.

C. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.

D. 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.
   3. Category 6A jacks shall be used.
   4. Data Jacks: 4-pair, pre-wired to T568B configuration.
   5. Product(s):
      a. Connector modules shall be Panduit CJ6X88TG..
         1) In locations where the minimum bend radius cannot be met such as in wire mold or modular furniture, utilize a Panduit 45 degree up/down wire cap or a Panduit 45 degree left/right wire cap.
            (a) Panduit CJUDCAPBU for up/down. or equal
            (b) Panduit CJLRCAPBU for left/right. or equal
      b. Jack Colors
         1) Data, telephone, Wireless Access Points Applications: Orange.
         2) Video Surveillance: Yellow.

E. Copper Patch Cords:
   1. Description: Factory-fabricated 4-pair cable assemblies with 8-position modular connectors terminated at each end.
      a. Approved Manufacturer: Ortronics, Allen Tel, Or Equal.
      b. Quantity: One per patch panel port. All jacks shall be active. Layout and routing will be defined by NDSU Enterprise Networks.
      c. Length: As needed to provide 10-14 inches (10" minimum, 14" maximum) of slack for each patch cord. Provide a mock-up of patch cable installation with approval from NDSU Facility Management (and / or NDSU Enterprise Networks) prior to completing patch cable install.
   2. Color: As indicated below
      a. Data, telephone, Wireless Access Points: Blue
      b. Video Surveillance: Yellow
   3. Labels: Patch cables shall be installed with wrap around labels on each end with the switch and patch panel information on both sides
      a. Example (*print the underlined identifiers on each end of the patch cable*):
         1) SW 1-23 -- (Switch 1 Port 23)
         2) PP 1-32 -- (Patch Panel 1 Port 32)
      b. Labels shall face so they are readable without twisting the cable when plugged into the switch and patch panels.
      c. Labels shall all face the same direction.
      d. If greater than 10% of labels are peeling within 1 year warranty period, all labels shall be replaced with a higher quality wrap around label to prevent future peeling.

2.04 FIBER OPTIC CABLE AND INTERCONNECTING DEVICES

A. Manufacturers:
   1. CommScope: www.commscope.com/#sle.

2. General Cable Technologies Corporation: www.generalcable.com/#sle.
3. AFL

B. Fiber Optic Backbone Cable:
1. Description: Tight buffered, indoor/outdoor rated, non-conductive fiber optic cable complying with TIA-568-C.3, TIA-598-D, ICEA S-83-596 and listed as complying with UL 444 and UL 1651.
2. Cable Type: Singlemode, 9/125 um (OS1), complying with TIA-492-CAAA. Singlemode, 9/125 um (OM1) complying with TIA-492CAAA.
3. Cable Capacity: Quantity of fibers as indicated on drawings.
4. Cable Applications:
   a. Plenum Applications: Use listed NFPA 70 Type OFNP plenum cable.
5. Cable Construction
   a. Interlocked armor with plenum rated non-conductive jacket.
   b. Water blocking with polymer coated yarn.
   c. Operating Temperature: -20 to +85 Celsius.
   d. Bend Radius: 15X outside diameter (installation), 10X (long term).
   e. Flex resistance: minimum 1,000 cycles.
6. Cable Jacket Color:
   a. Single-Mode Fiber (OS1/OS2): Yellow.
7. Product(s):
   a. OCC DX Series or equal by Approved Manufacturer.
   b. Substitutions according to provisions of Section - Electrical General Requirements.

C. Fiber Optic Cable for Fire Alarm
1. Description: Tight buffered, non-conductive fiber optic cable complying with TIA-568-C.3, ICEA S-83-596 and listed as complying with UL 444 and UL 1651.
2. Cable Type: Singlemode, 9/125 um (OS1).
3. Cable Capacity: 6 strand.
4. Cable Applications: Use listed NFPA 70 Type OFNP plenum cable unless otherwise indicated, any fiber not in conduit shall be interlocked.
5. Cable Jacket Color
   a. Single-Mode Fiber (OS1/OS2): Yellow
6. Product(s)
   a. OCC DX Series or equal by Approved Manufacturer.
   b. Substitutions according to provisions of Section - Electrical General Requirements.

D. Fiber Optic Interconnecting Devices:
1. Fiber Optic Adapters and Fuse On Connectors: Duplex SC connectors for both data and fire alarm fibers, adaptors with zirconia ceramic alignment sleeves; complying with relevant parts and addenda to latest edition of TIA/EIA-568 and with maximum attenuation of 0.5 dB at 1300 nm with less than 0.2 dB change after 500 mating cycles when tested in accordance with TIA-455-21

2.05 COMMUNICATIONS EQUIPMENT ROOM FITTINGS

A. Copper Cross-Connection Equipment:
1. Connector Blocks for Category 3 and Up Cabling: Type 110 insulation displacement connectors. Sized to fit EIA standard 19 inch wide equipment racks; 16 gauge steel with black powder coat finish; cabling terminated on modular connectors.
   a. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
   b. Hoffman DCHD2 horizontal wire management panels shall be provided above and below connector block panel frames for front and rear patch cable management.
   c. Panduit P110 series.
2. Patch Panels for Copper Cabling: Sized to fit EIA standard 19 inch wide equipment racks; 16 gauge steel with black powder coat finish; cabling terminated on modular connectors.
   a. 48 port, all metal construction, modular patch panel frames, populated with Category 6A jack connectors, by approved equipment manufacturer. The data network, telephones, wireless access points, cameras, shall all be mounted on separate patch panel fields. Coordinate with the owner.

1) For Data rooms with 1 or 3 racks use angled patch panels.
2) For Data rooms with 2 or 4 racks use flat patch panels.

b. Capacity: Provide ports sufficient for cables to be terminated plus 25 percent spare.
c. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
d. Provide incoming cable strain relief and routing guides on back of panel.

3. Product(s):
a. Panduit CP Series (Not the CPP series).

B. Fiber Optic Cross-Connection Equipment:
1. Patch Panels for Fiber Optic Cabling: Sized to fit EIA/ECA-310 standard 19 inch wide equipment racks; 0.09 inch thick aluminum.
a. 16 gauge steel construction, powder coated with black finish.
b. Size: for termination of fiber quantities as indicated on the drawings, plus 25% spare capacity
c. Adapters: As specified above under FIBER OPTIC CABLE AND INTERCONNECTING DEVICES; maximum of 24 duplex adaptors per standard panel width.
d. Labels: Factory installed laminated plastic nameplates above each port, numbered consecutively; comply with TIA-606.
e. Provide incoming cable strain relief and routing guides on back of panel.
f. Provide rear cable management tray at least 8 inches deep with removable cover.
g. Provide dust covers for unused adapters.
h. Panduit FRME Series.

C. Backboards: Interior grade type AC plywood without voids, 3/4 inch thick; UL-labeled fire-retardant.
1. Size: 48 inches wide by 96 inches high or as noted on the drawings.
2. Do not paint over UL label.
3. Paint Light Gray.

D. Equipment Frames, Racks and Cabinets:
1. Component Racks: EIA/ECA-310 standard 19 inch wide.
2. Floor Mounted Racks: Two post, open frame, heavy aluminum construction; vertical and horizontal cable management channels and grounding lug.
a. Description: Standard 19" rack meeting EIA-310-D standards. 84" high, aluminum construction, black in color. 45 rack spaces minimum.
b. Mounting: Floor mount. Secure to floor, wall structure and to ladder rack systems
c. Manufacturer
1) Chatworth 55053 Series.
2) Hoffman EDR Series.
3) Panduit R2P Series

E. Grounding and bonding: Provide vertically mounted, rack grounding strip equal to Hoffman 40172 Series in each rack. Bond each rack to local grounding bar

F. Power Management
1. Provide UL listed vertical power strip, 20 amp rated, (24) NEMA 5-20R outlets and an integral circuit breaker and 10 foot cord equal to Hoffman model DP1N622420.
2. Provide 1 per rack.

G. Cable Management:
1. Provide cable management for each rack as follows:
a. Vertical Wire Management: aluminum construction, powder coat finish, with hinged door, equal to Hoffman DV10D7 Series on each side of each rack.
b. Horizontal Wire Management to be equal to Hoffman DCHD2 Series. Provide one above and below each patch panel installed.
c. Hoffman DCHS2 for each fiber enclosure and for each rack mounted 110 connector block - quantity to equal the number of fiber enclosures plus connector block modules.
d. All Installed Ladder Rack: Minimum 18" wide, adjustable rung, black in color, equal to Chatworth 14300-718 Series. Install ladder rack the entire length of the MDF/IDF centered above the data racks

and then to the adjacent walls.

e. Adjust ladder rack rungs to avoid landing directly above the vertical cable management.
f. Install 6" elevation kits, Chatsworth 10506-706 or equal, on each rack to attach rack to ladder rack.
g. Provide Tool-less Cross Member Radius Drop Chatsworth 14304-718 or equal accessories for connecting overhead ladder rack to the data racks in BOTH directions above each vertical cable management, on each rack. (2 dropouts above each vertical management, installed such that cables may be dropped into the vertical management from both directions)
h. Route Ladder rack down walls to floor penetrations where ladder rack is routed up walls to overhead systems in MDF/IDF Rooms.
i. For vertical cable routes, secure cables to tray/ladder rack at no greater than 2 foot intervals utilizing 3/4" hook and loop cable fasteners.
j. For horizontal cable routes, secure before, in the middle and after route angle changes.

2.06 CABLE SUPPORT HANGERS

A. Products
1. Panduit J-Pro Series J-hook.
2. CADDY CAT HP Series J-hook.
3. CADDY CAT 425 Series adjustable strap hanger

B. Manufacturer guidelines shall be used for supporting/mounting the cable supports. Provide wall mount, ceiling mount, threaded rod clip, beam clamp, etc. mounting option as appropriate for the installation.
C. J-hooks or adjustable cable supports to be UL listed as suitable for air handling plenum spaces.
D. Provide a minimum of 50% spare capacity in each J-hook and cable support to provide for future needs.

2.07 COMMUNICATIONS OUTLETS

A. Outlet Boxes: Comply with Section 26 0533.16.
1. Provide depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
2. Wireless Access Points
a. Outlet boxes for wireless access point shall be dedicated to wireless access points. Do not combine with standard outlets.
b. Install 4 11/16 inch box with single gang mud ring.

B. 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: Minimum of 2 ports.
4. Wall Plate Material/Finish - Flush-Mounted Outlets: Match wiring device and wall plate finishes specified in Section 26 2726.
5. Plastic plates with label ID windows.
6. Product(s):
a. Panduit Mini-Com Classic Series faceplates.

2.08 GROUNDING AND BONDING COMPONENTS

A. Comply with TIA-607.
B. Comply with Section 26 0526.

2.09 IDENTIFICATION PRODUCTS

A. Comply with TIA-606.
B. Comply with Section 26 0553.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.
B. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
C. 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.

D. Do not install equipment and materials that have not been reviewed by the Architect. Equipment and materials which are installed without the Architect's review or without complying to comments issued with the review will be removed from the project when so instructed by the Architect. No payment will be made for unapproved or removal if it is ordered removed. The Installer will be responsible for any ancillary costs incurred because of its removal and the installation of the correct equipment and materials.
E. Refer to all Drawings associated with the project, prior to the installation to determine the exact location of all work.
F. Verify that interior of building has been protected from weather.
G. Verify that mechanical work likely to damage wire and cable has been completed.
H. Verify that raceway installation is complete and supported.

3.02 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. Cable Support Hangers
   1. Manufacturer guidelines shall be used for supporting/mounting the cable supports. Provide wall mount, ceiling mount, threaded rod clip, beam clamp, etc. mounting option as appropriate for the installation.
   2. Cable shall be supported at no greater than four-foot intervals for Category 6 cable. Provide a hook and loop fastener at each J-hook to retain and manage the cable bundle.
   3. Install J-hooks in all locations where conduit is not within 3 feet of cable tray.
   4. J-hooks shall be installed such that all pathways run either perpendicular to or parallel with building structure and at sufficient mounting heights and locations to prevent cables from resting on ceiling tiles, pipes, duct work or any other structures.
   5. Where elevation changes occur in hooks or cable tray, cables shall be adequately secured with 3/4" hook and loop fasteners.
C. Conduit, in Addition to Requirements of Section 26 0533.13:
   1. Arrange conduit to provide no more than the equivalent of two 90 degree bend(s) between pull points.
   2. Conduit Bends: Inside radius not less than 10 times conduit internal diameter.
   3. Arrange conduit to provide no more than 100 feet between pull points.
   4. Do not use conduit bodies.
D. Outlet Boxes:
   1. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of telecommunications outlets provided under this section.
   2. Wall mounted wireless access points
      a. Need to be mounted vertically on their own outlet box.
      b. Shall not be mounted on single or dual channel surface raceway.
   3. Ceiling mounted wireless access points
      a. Shall be mounted facing down,
      b. Shall be mounted at a height of at least 8 feet but not exceeding 14 feet.
      c. Nothing shall be mounted below a WAP. For example, no Ductwork, plumbing, or light fixtures.

3.03 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. Floor-Mounted Racks and Enclosures: Permanently anchor to floor in accordance with manufacturer's recommendations.
H. 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.
I. 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.

J. 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.

3.04 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 of the backbone cabling, unless otherwise instructed.
H. Contractor shall coordinate all cable pathways on site with other trades before construction.

3.05 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. Performance of materials will have been tested to provide fire rating equal to that of the construction.
F. 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.

G. 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.

H. 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.

I. 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.

J. 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.

K. 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.

L. 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.

3.06 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.

3.07 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

A. Comply with ANSI/TIA-607 B.

B. TBB placed in ferrous metallic conduit that exceeds 1m(3 ft) in length, will be bonded to each end of the conduit with a conductor sized as a NO. 6AWG, minimum.

C. The TBB conductor will be bonded to the service equipment (power) ground.

D. All Telecommunications Bonding Backbone (TBB) Cables will be insulated and installed in conduit between manholes, telecommunications closets, building steel frame and building electrical grounding system

E. TBB cables will interconnect all Telecommunications Grounding Busbars (TGB) with the Telecommunications Main Grounding Busbar (TMGB). The TBB will originate at the TMGB and extend throughout the building and

connects to all the TGB's in telecommunications closets and equipment rooms. See details on Drawings.

F. The TBB will be installed without splices, where practicable. If splices are necessary they will be minimum in number accessible and located in telecommunications spaces. Joined segments will be connected using irreversible compression-type connectors, exothermic welding or equivalent.

G. Unless noted otherwise, The TBB will be No. 3/0 AWG between TMGB and TGB's. The TBB from one TGB to another TGB will be No. 6 AWG. The TBB from TGB to the panel board in the same telecommunications space will be No. 6 AWG. All TBB connections to the TGB will utilize listed 2-hole compression connectors.

H. Exothermic welds will be used to connect TBB from TMGB or TGB and building steel frame. All other connections will use 2-hole compression connectors.

3.08 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. Patch cords shall be straightened prior to installation so they may be neatly trained, without coiling, when installed.

M. Group in bundles and secure with 3/4" hook and loop fasteners.

N. Securely mount equipment racks / cabinets per manufacturer's recommendations.

O. Provide 25% spare capacity at copper cross-connect blocks, patch panels, and cable management system for future expansion.

3.09 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.

E. Provide with color coordinated screw cover and clear station and port label covers.

3.10 TELECOMMUNICATION EQUIPMENT ROOM INSTALLATION

A. 25ft Service Loops for all backbone cables shall be provided at end of the cable. The cable shall be neatly bundled and stored on wall or in ceiling for future expansion.
   1. Support service loops in at least 2 positions on each loop, with some service loops requiring more supports (ex. 10 and 2, 12 and 6, 3 and 9).
   2. Do not loop cabling in the cable tray.
   3. Loops shall be secured away from the primary cable pathway and shall not obstruct access to other cables, cable tray, or other above ceiling services or equipment.

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. Slack or Excess Length of cables at termination point: Provide the following minimum extra length of cable, looped neatly and uniformly
   1. At Distribution Frames: Copper 12 inches.
   2. At Distribution Frames: Fiber 120 inches.
   3. At Outlets - Copper: 12 inches.
   4. At Outlets (specifically all outlets located in individual or small group offices) – Copper: Provide 10 feet excess length coiled above ceiling.
   5. At Outlets - Optical Fiber: 39 inches

D. 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.

E. Bonding and Grounding:
   1. See specification Section 26 0526.
   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.

F. Copper backbone cable shall be landed on a 110 style cross field. Terminated to 568B wiring specifications.

G. Cable shall be terminated on the same category rated blocks or higher than the installed cable.

H. 110 Connecting Blocks shall be rack mounted.

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.

3.11 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. 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.
D. All wires shall be marked at all junction boxes, pull boxes, cabinets, boxes and terminations.
E. 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.
F. 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
G. 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
H. 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.
I. 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
J. 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.
K. Contractor shall use only cable lubricants recommended by the manufacturer for use with the specific cable construction.
L. 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.
M. 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 2-foot intervals.
N. Outside Plant Cable
    1. Cable service loops shall be included in each manhole to allow for proper cable dressing, splicing the cable outside the manhole in a controlled space and for repairing damaged cable
    2. Install sufficient cable slack to remove cable from the manhole for splicing in a splice van or tent
    3. In addition to the cable slack required for proper termination/splicing in a splice enclosure, the Contractor shall install sufficient cable slack to form at least one loop of cable along the inner perimeter of the manhole
    4. Where no cable splice is planned for a manhole, the contractor shall leave sufficient slack to form at least twp loops of cable along the inner perimeter of the manhole
    5. Cable service loop lengths shall be adjusted based on manhole size, manhole depth and existing conditions
    6. Cables slack shall be securely fastened to all four walls of the manhole. Furnish and install bracket arms for securing and mounting of all cables where built-in racking exists
    7. If racking is not furnished in a manhole, furnish and install a cable sling of weather, water, oil and solvent resistant material to support the cable(s) on those walls without built in racking.
    8. Cable splice enclosures shall be security fastened to mounting arm brackets attached to manhole racking. Furnish and install racking and mounting arm brackets to support splice cases. Cable splice enclosures shall be attached to at least two racks in the manhole
    9. All cables shall be secured to bracket arms using cable ties and straps resistant to weather, water, oil, fuel and solvents. Plastic or stainless steel ties/straps rated for this application shall be acceptable for use
    10. All cable dressing in manholes shall be performed so that the minimum bend radius of cables is not exceeded

11. All cable splice enclosures shall be mounted either on the long wall of the manhole or on the wall parallel with the main cable run entry and exit conduits.
12. Wherever possible in existing manholes, and as a standard for manholes furnished and installed under this or an associated project, optical cable splice enclosures shall be mounted on one long wall (or parallel wall as previously defined) and copper cable splice enclosures shall be mounted on the opposite wall.
13. Wherever possible, large pair count copper cable enclosures shall be mounted at the vertical mid-line of the manhole and fiber cable splice enclosures shall be mounted at or above the vertical mid-line.
14. All cables shall be spliced in splice enclosures as specified herein.
    a. Furnish and install the maximum slack in each enclosure as recommended by the cable, splice system and enclosure manufacturer.
    b. Furnish and install all splice trays, splice holders, splice tray holders, mounting brackets, frames, grounding and other ancillary hardware and materials as required by the cable manufacturer, splice system manufacturer, splice enclosure manufacturer and standard industry practices.
    c. Only technicians trained in the proper assembly of enclosures, splices and splicing procedures shall be permitted to splice cables.

O. 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.

3.12 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. Cables shall be identified at each end. Same designation shall be used at both ends.
1. Provide wire markers on backbone cabling with the following:
    a. Format: Source Building Name / Source Room Number / Strand or Pair Count
D. Racks shall be identified as indicated on Drawings. If not designation are made on the Drawings submit an RFI with suggested naming convention.
E. 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.

3.13 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.

3.14 BACKBONE CABLE FIELD QUALITY CONTROL

A. On completion of the cable installation and termination the cable shall be tested before put into use.

B. Category 3 Copper Cable Testing
   1. Cable tester will be NRTL certified for EIA/TIA TSB95.
   2. 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
   3. 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
   4. Tests will be based on each pair of conductors and not the aggregate multiple pair results
   5. Test all installed cable segments end-to-end, from each telecommunications room backbone patch panel/cross-connect block panel to respective main cross connect.
   6. 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
   7. The contractor shall perform 100% testing of all newly installed backbone cable.
   8. Test Results shall include:
      a. Applicable Telecommunications Room number
      b. Wire Map - will 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
C. 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 shall 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. Single-Mode Fiber Optic Cables
   a. Single Mode Backbone: Perform tests in accordance with TIA-526-7 Method B
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 labeling scheme.
   4. Review features and special functions.
   5. Review maintenance requirements.
   6. Review operation and maintenance manuals.
   7. 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.

END OF SECTION

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SECTION 27 4000 - CLASSROOM AUDIO VIDEO CABLING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cabling for projectors.
B. Cabling for monitors.
C. Cabling for interactive white boards.

1.02 REFERENCES

A. NFPA 70 National Electrical Code.
B. NEMA WD 6

1.03 DESCRIPTION OF WORK

A. Provide UTP category cabling between input points and display points.
B. Provide audio cabling for speakers.

1.04 QUALITY ASSURANCE

A. Furnish Products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and indicated.
B. Installer Qualifications:
    1. A firm currently engaged and which has been continuously engaged for the past 5 years in the installation of applications of type required for this Project, and which can provide documentation of four completed projects similar in size and complexity to this project.
    2. The installing Contactor shall have a minimum one (1) Certified Installer trained to the latest industry standards to ensure the most reliable installation available.
    3. The Contractor shall have one (1) Certified BICSI Technician for every five (5) labors.
    4. The Contractor shall have written documentation stating the Level III Tester used on this project has been factory calibrated within the last 12 months.
C. Source Limitations: Obtain units of the same type of equipment through one source from a single manufacturer.
D. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years of experience.
E. Supplier: Authorized distributor of specified manufacturer with minimum three years experience.

1.05 SUBMITTALS FOR REVIEW

A. Submit according to the requirements of Division 01 and Section - Electrical General Requirements.
B. Provide manufacturer's data sheets for each product specified including:
    1. Preparation instructions and recommendations.
    2. Storage and handling requirements and recommendations.
    3. Installation methods.
C. Provide Installer Qualifications.

1.06 SUBMITTALS FOR CLOSEOUT

A. Submit according to the requirements of Division 1 and Section - Operation and Maintenance of Electrical Systems.
B. Record Drawings: Include elevations of equipment racks and cabinets with labels and floor plans with outlets labeled corresponding to labeling indicated on rack elevations.
C. Operation and Maintenance Manuals include information noted in section Operation and Maintenance Manuals for Electrical Systems and the documentation required by Part 3.

PART 2 PRODUCTS

2.01 CABLING PATHWAY

A. See Section 26 0533.13 for conduit and 26 0533.16 for boxes.

2.02 CABLING

A. UTP cabling shall be installed as specified in section 27 1000.
    1. Any and all references to Cat6 cabling shall refer to the Category 6A cabling specified in section 27 1000.
B. Audio (Speaker) Cabling
    1. Jacketed, twisted pair and twisted multipair, untinned solid copper.
        a. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.
        b. Plenum Cable: Listed and labeled for plenum installation.

c. 16 Gauge minimum.

2.03 RACEWAYS

A. Conduit and Boxes: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems."
   1. Outlet boxes shall be not less than 2 inches wide, 4 inches high, and 2-1/2 inches deep.

2.04 WALL PLATES

A. As specified in section 27 1000 and 26 2726.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.
B. Verify that mechanical work likely to damage wire and cable has been completed.
C. Verify that raceway installation is complete and supported.

3.02 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.
B. Coordinate layout and installation of wall plates with Owner.
C. The contractor shall not be responsible for making the cross connect between the indoor cable termination and the OSP cable field, unless otherwise instructed.
D. Contractor shall coordinate all cable pathways on site with other trades before construction.

3.03 INSTALLATION

A. All cables shall be installed to suggested manufactures instructions. Follow bend radius and pulling tension guide lines.
B. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
C. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
D. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
E. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
F. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
G. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.
H. Open Cable Installation
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.
   3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
I. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.
J. Cable tywraps may be used to secure installation of cables. Synching down on installed cable will not be permitted if cables geometry is changed. Plenum rated tywraps must be used in all Plenum air spaces
K. Labeling and Identification: Provide label at nameplate and at each end of cable. Verify label convention with Owner prior to beginning.
L. All face plates shall be installed in a vertically plumb position, if this is not possible, notify other trades for corrective action.
M. Excess cable service loops shall not be stored in back box, cables should be pulled back into ceiling space.
N. All un-used plate opening shall be filled with blanks.
O. All face plates locations shall be labeled according to specification section Identification for Electrical Systems.

3.04 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.

END OF SECTION

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SECTION 27 5129.13 - RESCUE ASSISTANCE SIGNAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Area of rescue assistance emergency communication system and associated call stations, control stations, and accessories.

1.02 REFERENCE STANDARDS

A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
E. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
    1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment or other potential obstructions within the spaces dedicated for area of refuge/rescue assistance system components.
    2. Coordinate the work with other installers to provide communication lines required for control station timed automatic connection to designated constantly attended monitoring location.
    3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
B. Sequencing:
    1. Do not install call stations and control station(s) until final surface finishes and painting are complete.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.
C. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include system interconnection schematic diagrams.
D. Operation and Maintenance Data: Include detailed information on system operation, equipment setup, replacement parts, and recommended maintenance procedures and intervals.
E. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.
F. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.

1.05 QUALITY ASSURANCE

A. Comply with the following:
    1. ADA Standards.
    2. NFPA 70 (National Electrical Code).
    3. Applicable TIA/EIA standards.
B. Products: Listed, classified, and labeled as suitable for the purpose intended.
C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.
B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.07 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.08 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Area of Refuge/Rescue Assistance Communication System:
   1. Cornell Communications: www.cornell.com/#sle.
   2. Housing Devices, Inc: www.housingdevices.com/#sle.
   3. Rath Microtech: www.area-of-refuge.com/#sle.

B. Substitutions: See Section 01 6000 - Product Requirements.

2.02 AREA OF REFUGE/RESCUE ASSISTANCE COMMUNICATION SYSTEM

A. Provide new area of refuge/rescue assistance communication system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, accessories, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. System Description:
   1. Call Stations: Located at each designated area of refuge/rescue assistance as indicated on drawings, unless otherwise directed by authorities having jurisdiction.
   2. Master Control Station: New, located as indicated on drawings, unless otherwise directed by authorities having jurisdiction.
   3. Timed automatic connection to designated constantly attended monitoring location is required.

C. System Operation:
   1. When a call for assistance is initiated at call station:
      a. Provide audible and visual notification at call station to confirm that call has been placed.
      b. Provide audible and visual notification at control station(s) that call has been placed and annunciate the location of the call station/zone that initiated a call.
      c. Maintain visual notification of each call location at control station(s) until manually reset by control station operator.
      d. Maintain audible notification at control station(s) that call(s) have been placed until call is acknowledged by control station operator.
      e. Maintain visual notification at call station until manually reset by control station operator.
   2. When a call for assistance is acknowledged at control station:
      a. Provide visual notification at control station that call has been acknowledged.
      b. Provide visual notification at call station that call has been received.
      c. Establish two-way voice communication between call station and control station.
   3. When a call has not been acknowledged during a programmed time delay to allow for local response, automatically initiate call to listed remote monitoring station under contract with facility, send signal identifying specific building, and establish two-way voice communication.

D. Call Station(s):
   1. Suitable for the environment where installed.
   2. Finish: Painted steel or stainless steel.
   3. Mounting: Flush-mounted.
   4. Provides means to initiate call for assistance.
   5. Provides for distinct audible and visual notification to confirm that call has been placed and for distinct visual notification that call has been acknowledged.
   6. Following initial call for assistance, provides for hands-free two-way communication with control station(s).

E. Control Station(s):
   1. Suitable for the environment where installed.
   2. Provides visual notification that system is operational.
   3. Provides for distinct audible and visual notification of calls with annunciation of call station/zone locations.

4. Provides for two-way communication with selected call stations.
5. Provides for supervision of system wiring and provides distinct audible and visual notification of faults.
6. Audible Notification Sound Level: Not less than 90 dB.

F. Accessories:
1. Provide components as indicated or as required for a complete operating system.
2. Wiring: Provide manufacturer's recommended cables as indicated or as required for connections between system components, and in accordance with wiring methods indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that characteristics of system components are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive system components.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Wiring Method:
1. Use 2-hour fire-rated circuit integrity (CI) cable or 2-hour fire-rated mineral-insulated, metal-sheathed (MI) cable in accordance with NFPA 72 Level 2/Level 3 pathway survivability requirements.
a. Exception: Buildings of less than 2-hour fire-rated construction that are fully protected by an automatic sprinkler system, where cables are installed in metal raceway or metal armored cables are utilized in accordance with NFPA 72 Level 1 pathway survivability requirements.
b. Exception: Cable may be routed entirely within 2-hour rated walls and underground using standard signal cabling
2. Provide Class A system wiring in accordance with NFPA 72 pathway performance requirements.
3. Use listed plenum rated cables in spaces used for environmental air.
4. Install wiring in conduit where required for rough-in, where required by authorities having jurisdiction, and where exposed to damage.
5. Conduit: Comply with Section 26 0533.13.
6. Conceal all cables unless specifically indicated to be exposed.
7. Route exposed cables parallel or perpendicular to building structural members and surfaces.

D. Provide grounding and bonding in accordance with Section 26 0526.
E. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
F. Identify system wiring and components in accordance with Section 26 0553.
G. Identify zones at control station(s) to indicate call station locations.
H. Provide required instructional signage at each call station.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Test to verify wiring is free of shorts and grounds.
C. Prepare and start system in accordance with manufacturer's instructions.
D. Test system for proper operation.
E. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
B. See Section 01 7900 - Demonstration and Training, for additional requirements.

C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
D. Training: Train Owner's personnel on operation, adjustment, 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.

3.06 PROTECTION

A. Protect installed system components from subsequent construction operations.

END OF SECTION

SECTION 27 5313 - CLOCK SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Clock system requirements.

B. Wireless clock systems and associated components:

1. Wireless secondary indicating clocks furnished by Owner and installed by Contractor.

C. Accessories.

1.02 REFERENCE STANDARDS

A. 47 CFR 15 - Radio Frequency Devices; current edition.

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.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the placement of clocks with potential conflicts and/or view obstructions installed under other sections or by others.
2. Coordinate the work with other installers to provide power for clocks and equipment at required locations.
3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install clocks until final surface finishes and painting are complete.

1.04 QUALITY ASSURANCE

A. Comply with the following:

1. 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.

1.05 DELIVERY, STORAGE, AND HANDLING

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

B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.06 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

PART 2 PRODUCTS

2.01 CLOCK SYSTEM REQUIREMENTS

A. Provide modifications and extensions to existing clock system consisting of all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the functional intent indicated.

B. Interface with Existing Clock System:

1. Existing Master Clock Unit:
   a. Manufacturer/Model: Primex Wireless.

C. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B, consumer application.

2.02 WIRELESS CLOCK SYSTEMS

A. Manufacturers:

1. Wireless Clock System:
   a. Primex.

B. Digital Wireless Secondary Indicating Clocks: (Furnished by Owner Installed by Contractor)

1. Power Source: 120 VAC; provide required transformers.
2. Time Reference Source: Synchronized with master clock unit wireless time correction signal.
3. Clock Display:
   a. Display Size: 4-digit (hours, minutes).

b. Digit Size: 2.3 inch, minimum.
c. Digit Color: Red.
4. Case Material/Color/Finish: Black.
5. Mounting: Surface.
6. Features:
a. Adjustable brightness.
b. Selectable 12 or 24-hour time format.

C. Provide components as indicated or as required for extension of wireless time correction signal between master clock unit and wireless secondary indicating clocks.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that characteristics of system components are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive system components.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Wiring Method for NFPA 70 Class 2 and Class 3 Circuits: Unless otherwise indicated, use cables (not in conduit), where permitted by code.
1. Use suitable listed cables in wet locations, including underground raceways.
2. Use suitable listed cables for vertical riser applications.
3. Use listed plenum rated cables in spaces used for environmental air.
4. Install wiring in conduit for the following:
a. Where required for rough-in.
b. Where required by authorities having jurisdiction.
c. Where exposed to damage.
d. Where installed outside the building.
e. For exposed connections from outlet boxes to devices.
5. Conduit: Comply with Section 26 0533.13.
6. Conceal all cables unless specifically indicated to be exposed.
7. Cables in the following areas may be exposed, unless otherwise indicated:
a. Equipment closets.
b. Within joists in areas with no ceiling.
8. Route exposed cables parallel or perpendicular to building structural members and surfaces.
9. Do not exceed manufacturer's recommended maximum cable length between components.

D. Provide grounding and bonding in accordance with Section 26 0526.
E. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
F. Identify system wiring and components in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Prepare and start system in accordance with manufacturer's instructions.
C. Program system parameters according to requirements of Owner.
D. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
E. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

B. See Section 01 7900 - Demonstration and Training, for additional requirements.
C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
D. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
    1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

3.06 PROTECTION

A. Protect installed system components from subsequent construction operations.

END OF SECTION

SECTION 28 1000 - ACCESS CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Access control system requirements.
B. Access control point peripherals, including readers and keypads furnished by Owner Installed by Contractor.
C. Accessories.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.
B. Section 08 7100 - Door Hardware: Electrically operated door hardware, for interface with access control system.
C. Section 26 0526 - Grounding and Bonding for Electrical Systems.
D. Section 26 0533.13 - Conduit for Electrical Systems.
E. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.03 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.
C. NFPA 101 - Life Safety Code; 2015.
D. UL 294 - Access Control System Units; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
    1. Coordinate the work with other installers to provide suitable door hardware as required for both access control functionality and code compliance.
    2. Coordinate the placement of readers with millwork, furniture, equipment, etc. installed under other sections or by others.
    3. Coordinate the work with other installers to provide power for equipment at required locations.
    4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
B. Preinstallation Meetings:
    1. Conduct meeting with facility representative and other related equipment manufacturers to discuss access control system interface requirements.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for composite cabling.
C. Field quality control test reports.
D. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.
E. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
    1. See Section 01 6000 - Product Requirements, for additional provisions.

1.06 QUALITY ASSURANCE

A. Comply with the following:
    1. NFPA 70.
    2. NFPA 101 (Life Safety Code).
    3. The requirements of the local authorities having jurisdiction.
    4. Applicable TIA/EIA standards.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.
B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.08 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Access Control Units: Avigilon. Furnished by Owner installed by Contractor.
B. Access Control Software - Basis of Design: Avigilon. This system will be an extension of the existing Avigilon system on campus.
C. Readers and Keypads - Basis of Design: Avigilon. Furnished by Owner installed by Contractor.

2.02 ACCESS CONTROL SYSTEM REQUIREMENTS

A. Install new access control system consisting of required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, and cooperation with the Owner as necessary for a complete operating system that provides the functional intent indicated. Existing to remain devices shall be incorporated into the new system to create one complete system.
B. Provide products listed, classified, and labeled as suitable for the purpose intended.
    1. Access Control Units and Readers: Listed and labeled as complying with UL 294.

2.03 ACCESSORIES

A. Provide components as indicated or as required for connection of access control system to devices and other systems indicated.
B. Provide cables as indicated or as required for connections between system components.
C. Provide accessory racks/cabinets as indicated or as required for equipment mounting.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that ratings and configurations of system components are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive system components.
D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install access control system in accordance with NECA 1 (general workmanship).
B. Install products in accordance with manufacturer's instructions.
C. Wiring Method: Unless otherwise indicated, use cables (not in conduit) routed via the structured cabling cable support system within the facility, route via conduit within walls and at non-accessible ceilings.
    1. Use suitable listed cables in wet locations, including underground raceways.
    2. Use suitable listed cables for vertical riser applications.
    3. Use listed plenum rated cables in spaces used for environmental air.
    4. Install wiring in conduit for the following:
        a. Where required for rough-in.
        b. Where required by authorities having jurisdiction.
        c. Where exposed to damage.
        d. Where installed outside the building.
        e. For exposed connections from outlet boxes to devices.
    5. Conduit: Comply with Section 26 0533.13.
    6. Conceal cables unless specifically indicated to be exposed.
    7. Use power transfer hinges complying with Section 08 7100 for concealed connections to door hardware.
    8. Route exposed cables parallel or perpendicular to building structural members and surfaces.
    9. Do not exceed manufacturer's recommended maximum cable length between components.
D. Provide grounding and bonding in accordance with Section 26 0526.
E. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
F. Identify system wiring and components in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Prepare and start system in accordance with manufacturer's instructions.
C. Program system parameters according to requirements of Owner.

D. Test for proper interface with other systems.
E. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
B. See Section 01 7900 - Demonstration and Training, for additional requirements.
C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

END OF SECTION

SECTION 28 2000 - VIDEO SURVEILLANCE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Video surveillance system requirements.
B. Cameras furnished by Owner installed by Contractor.
C. Accessories.

1.02 REFERENCE STANDARDS

A. 47 CFR 15 - Radio Frequency Devices; current edition.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
C. NECA 303 - Standard for Installing Closed-Circuit Television (CCTV) Systems; 2005.
D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
    1. Coordinate the placement of cameras with structural members, ductwork, piping, equipment, luminaires, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
    2. Coordinate the work with other installers to provide power for cameras and equipment at required locations.
    3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
B. Preinstallation Meetings: Review door schedule and installation requirements at each opening.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.
C. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
D. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Comply with the following:
    1. NFPA 70.
    2. Applicable TIA/EIA standards.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
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 three years documented experience with video surveillance systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer's representative.
    1. Contract maintenance office located within 100 miles of project site.
E. Maintenance Contractor Qualifications: Same entity as installer.
F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and NECA 303.
B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.07 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.08 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Video Recording and Viewing Equipment:
   1. NDSU's existing Avigilon video recording and viewing system will be utilized.
B. Cameras: Owner furnished Contractor installed.

2.02 VIDEO SURVEILLANCE SYSTEM

A. Install new video surveillance system consisting of all required equipment, conduit, boxes, wiring, connectors, supports, accessories, sas necessary for a complete installation including aiming cameras as directed by the Owner.
B. System Description: IP system with connection to network (IP) cameras.
C. Provide products listed, classified, and labeled as suitable for the purpose intended.
D. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B, consumer application.

2.03 ACCESSORIES

A. Provide components as indicated or as required for connection of video surveillance system to devices and other systems indicated.
B. Provide components as indicated or as required for system power and network connections.
C. Provide cables as indicated or as required for connections between system components.
   1. Data Cables for IP Network Connections: Unshielded twisted pair (UTP) complying with Section 27 1000.
D. Provide accessory racks/cabinets as indicated or as required for equipment mounting.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that ratings and configurations of system components are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive system components.
D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system where applicable.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install video surveillance system in accordance with NECA 1 (general workmanship) and NECA 303.
B. Install products in accordance with manufacturer's instructions.
C. Provide required support and attachment in accordance with Section 26 0529.
D. Wiring Method: Unless otherwise indicated, use cables (not in conduit).
   1. Use suitable listed cables in wet locations, including underground raceways.
   2. Use suitable listed cables for vertical riser applications.
   3. Use listed plenum rated cables in spaces used for environmental air.
   4. Install wiring in conduit for the following:
      a. Where required for rough-in.
      b. Where required by authorities having jurisdiction.
      c. Where exposed to damage.
      d. Where installed outside the building.
      e. For exposed connections from outlet boxes to cameras.
   5. Conduit: Comply with Section 26 0533.13.
   6. Conceal all cables unless specifically indicated to be exposed.
   7. Cables in the following areas may be exposed, unless otherwise indicated:
   8. Route exposed cables parallel or perpendicular to building structural members and surfaces.
E. Provide grounding and bonding in accordance with Section 26 0526.
F. Identify system wiring and components in accordance with Section 26 0553.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.
B. Prepare and start system in accordance with manufacturer's instructions.

C. Adjust cameras to provide desired field of view and produce suitable images under all service lighting conditions.
D. Program system parameters according to requirements of Owner.
E. Test for proper interface with other systems.
F. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
B. See Section 01 7900 - Demonstration and Training, for additional requirements.
C. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.

END OF SECTION

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SECTION 28 4600 - FIRE DETECTION AND ALARM

FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fire alarm system design and installation, including all components, wiring, and conduit.
B. Transmitters for communication with supervising station.
C. Circuits from protected premises to supervising station, including fiber optic cable, and conduit.
D. Modifications and removal of existing fire alarm system components, wiring, and conduit indicated.

1.02 REFERENCE STANDARDS

A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
C. ANSI/ASA S3.2 - Method for Measuring the Intelligibility of Speech over Communication Systems; 2020.
D. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Cor 1, 2012).
E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
F. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.
G. NFPA 101 - Life Safety Code; 2015.
H. UL 268 - Standard for Smoke Detectors for Fire Alarm Systems; Current Edition, Including All Revisions.
I. UL 268A - Standard for Smoke Detectors for Duct Application; Current Edition, Including All Revisions.
J. UL 464 - Standard for Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories; Current Edition, Including All Revisions.
K. UL 521 - Standard for Heat Detectors for Fire Protective Signaling Systems; Current Edition, Including All Revisions.
L. UL 1638 - Standard for Visible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories; Current Edition, Including All Revisions.
M. UL 1971 - Standard for Signaling Devices for the Hearing Impaired; Current Edition, Including All Revisions.
N. UL 2034 - Standard for Single and Multiple Station Carbon Monoxide Alarms; Current Edition, Including All Revisions.
O. UL 2075 - Standard for Gas and Vapor Detectors and Sensors; Current Edition, Including All Revisions.
P. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2021.
Q. Local Jurisdiction Adopted Codes and Standards
R. UL 1424 - Cables for Power-Limited Fire-Alarm Circuits.
S. UL 2196 - Testing Electrical Systems

1.03 DESCRIPTION OF SYSTEM

A. System Modifications: Provide modification of the current system at the areas indicated for remodel and/or addition on plans. Provide compatible new hardware and fully integrate with the existing system.
B. New Fire Alarm System with Voice Annunciation: Provide a complete new fire alarm system capable of using high-fidelity speakers to deliver pre-recorded, custom, and live messages.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for installed components and accessories.
C. Shop Drawings: Indicate dimensions and installed features and accessories.
    1. Include wiring diagrams showing all factory and field connections.
D. Voice Message Scripts: indicate message script and voice to be used from manufacturer.
E. Proposal Documents: Submit the following with cost/time proposal:
    1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
    2. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
    3. Certification by Contractor that the system design will comply with Contract Documents.

4. Proposed maintenance contract.

F. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
   1. Copy (if any) of list of data required by authority having jurisdiction.
   2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
   3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
   4. System zone boundaries and interfaces to fire safety systems.
   5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
   6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
   7. List of all devices on each signaling line circuit, with spare capacity indicated.
   8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
   9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
   10. Detailed drawing of graphic annunciator(s).
   11. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
   12. Certification by the manufacturer of the control unit that the system design complies with Contract Documents.
   13. Certification by Contractor that the system design complies with Contract Documents.
   14. Do not show existing components to be removed.

G. Qualifications:
   1. Evidence of designer qualifications.
   2. Evidence of installer qualifications.
   3. Evidence of instructor qualifications; training lesson plan outline.

H. Inspection and Test Reports:
   1. Submit inspection and test plan prior to closeout demonstration.
   2. Submit documentation of satisfactory inspections and tests.
   3. Submit NFPA 72 "Inspection and Test Form," filled out.

I. Operating and Maintenance Data: See Section 01 7800 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
   1. Original copy of NFPA 72 with portions that are not relevant to this project neatly crossed out by hand; label with project name and date.
   2. Complete set of specified design documents, as approved by authority having jurisdiction.
   3. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
   4. Contact information for firm that will be providing contract maintenance and trouble call-back service.
   5. List of recommended spare parts, tools, and instruments for testing.
   6. Replacement parts list with current prices, and source of supply.
   7. Detailed troubleshooting guide and large scale input/output matrix.
   8. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
   9. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.

J. Project Record Documents: See Section 01 7800 for additional requirements; have one set available during closeout demonstration:
   1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
   2. "As installed" wiring and schematic diagrams, with final terminal identifications.

3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.

K. Closeout Documents:
   1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
   2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
   3. Certificate of Occupancy.

L. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
   3. In addition to the items in quantities indicated in PART 2, furnish the following:
      a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
      b. One copy, on CD-ROM, of all software not resident in read-only-memory.
      c. Extra Fuses: Two for each installed fuse; store inside applicable control cabinet.

1.05 QUALITY ASSURANCE

A. Copies of Design Criteria Documents: Maintain at the project site for the duration of the project, bound together, an original copy of NFPA 72, the relevant portions of applicable codes, and instructions and guidelines of authorities having jurisdiction; deliver to Owner upon completion.

B. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer , with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.

C. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
   1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
   2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
   3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
   4. Contract maintenance office located within 50 miles of project site.
   5. Certified in the State in which the Project is located as fire alarm installer.

D. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

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

1.06 EXTRA MATERIALS

A. General: Furnish extra materials, packaged with protective covering for storage, and identified with labels clearly describing contents as follows:
   1. Notification Appliances: Furnish quantity equal to 5 percent of the number of units of each type installed but not less than one of each type.
   2. Smoke Detectors or Sensors: Furnish quantity equal to 5 percent of the number of units of each type installed but not less than one of each type.
   3. Detector or Sensor Bases: Furnish quantity equal to 2 percent of the number of units of each type installed but not less than one of each type.
   4. Manual Pull Stations: Furnish quantity equal to 2 percent of the number of units installed, but not less than one.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.
C. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fire Alarm Control Units and Accessories:
   1. Simplex, a brand of Johnson Controls: www.simplex-fire.com/#sle.
B. Initiating Devices and Notification Appliances:
   1. Simplex, a brand of Johnson Controls: www.simplex-fire.com/#sle.
   2. Same manufacturer as control units.
C. Substitutions: See Section 01 6000 - Product Requirements.
   1. For substitution of products by manufacturers not listed, submit product data showing features and certification by Contractor that the design will comply with Contract Documents.

2.02 FIRE ALARM SYSTEM

A. Fire Alarm Control Panel: the existing Fire Alarm Control Panel to remain. Provide modifications, extensions and required programming.
B. Fire Alarm System: Provide a new automatic fire detection and alarm system:
   1. Provide all components necessary, regardless of whether shown in Contract Documents or not.
   2. Protected Premises: Entire building shown on drawings.
   3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
      a. ADA Standards.
      b. The requirements of the State Fire Marshal.
      c. The requirements of the local authority having jurisdiction.
      d. Applicable local codes.
      e. Contract Documents (drawings and specifications).
      f. NFPA 101.
      g. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
   4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
   5. Voice Notification: Provide emergency voice/alarm communications with multichannel capability; digital.
      a. Audio Zones; minimum of one zone per floor. Provide digital audio files for the following conditions that also incorporate warning tones prior to the digital voice announcement:
         1) Fire Alarm
         2) All Clear
   6. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
   7. Program notification zones as indicated on drawings.
   8. Hearing Impaired Occupants: Provide visible notification devices in all public areas and in dwelling units.
   9. Fire Alarm Control Unit: New, located at the location indicated on drawings..
   10. Combined Systems: Do not combine fire alarm system with other non-fire systems.
C. Supervising Stations and Fire Department Connections:
   1. Public Fire Department Notification: By remote supervising station.
   2. Remote Supervising Station: Existing proprietary station operated by Owner, located at campus.
   3. Means of Transmission to Remote Supervising Station: Digital alarm communicator transmitter (DACT), fiber optic.
D. Circuits:
   1. Initiating Device Circuits (IDC): Class B, Style A.
   2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
   3. Notification Appliance Circuits (NAC): Class B, Style W.

E. Spare Capacity:
   1. Initiating Device Circuits: Minimum 25 percent spare capacity.
   2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
   3. Speaker Amplifiers: Minimum 25 percent spare capacity.
   4. Fire Alarm Control Units: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.
F. Power Sources:
   1. Primary: Dedicated branch circuits of the facility power distribution system.
   2. Secondary: Storage batteries.
   3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
   4. Each Computer System: Provide uninterruptible power supply (UPS).

2.03 EXISTING COMPONENTS

A. Existing Fire Alarm System: Remove existing components indicated and incorporate remaining components into new system, under warranty as if they were new; do not take existing portions of system out of service until new portions are fully operational, tested, and connected to existing system.
B. On-Premises Supervising Station: Include as part of this work all modifications necessary to existing supervising station to accommodate new fire alarm work.
C. Clearly label components that are "Not In Service."
D. Remove unused existing components and materials from site and dispose of properly.

2.04 FIRE SAFETY SYSTEMS INTERFACES

A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
   1. Sprinkler water control valves.
   2. Dry-pipe sprinkler system pressure.
   3. Dry-pipe sprinkler valve room low temperature.
   4. Sprinkler water storage tank low level.
   5. Sprinkler water storage tank low temperature.
   6. Fire pump(s).
   7. Elevator shut-down control circuits.
   8. Carbon monoxide detectors.
   9. Duct smoke detectors.
   10. Open circuits, shorts, and grounds in designated circuits.
   11. Ground or a single break in fire alarm control unit internal circuits.
   12. Abnormal AC voltage at fire alarm control panel.
   13. Break in standby battery circuitry.
   14. Failure of battery charging.
   15. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
   16. Loss of primary power at fire alarm control panel.
   17. Lab gas detected by lab gas detection control unit.
   18. Loss of primary power at lab gas detection control unit.
   19. Abnormal position of any switch at fire alarm control panel or annunciator.
   20. Abnormal position of manual temporary switch at fire pump emergency power circuit.
B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
   1. Sprinkler water flow.
   2. Total flooding suppression system activation.
   3. Kitchen hood suppression activation; also disconnect fuel source from cooking equipment.
   4. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.
   5. Generator room heat detector.
C. Elevators:
   1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.
   2. Elevator Machine Room Heat Detector: Shut down elevator power prior to hoistway sprinkler activation.
   3. Sprinkler pressure or waterflow: Shut down elevator power prior to hoistway sprinkler activation.
D. HVAC:

1. Duct Smoke Detectors: Close affected dampers and/or air handling units.

E. Doors:
   1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 7100.
   2. Electromagnetic Door Locks on Egress Doors: Unlock upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from. Refer to Section 08 7100.
   3. Overhead Coiling Fire Doors: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 3323.

F. Access Control System:
   1. Door Locks on Egress Doors: Signal access control system to unlock egress doors upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from. Refer to Section 08 71 00.

G. Flammable Gas Control for Labratories or Kitchens:
   1. Signal gas supply solenoid valve using addressable fire alarm module upon any alarm event.

2.05 COMPONENTS

A. General:
   1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
   2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.

B. Fire Alarm Control Units: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.

C. Master Control Unit:
   1. Custom Programming Buttons: control panel shall include buttons for custom programming inputs with LED indicator and space for printed label and next to each button. Program the following functions to the custom buttons:
      a. Emergency Evacuation Announcement
      b. Carbon Monoxide Announcement
      c. Test Announcement
      d. All Clear Announcement
      e. Severe Weather Announcement
      f. Lockdown Announcement

D. Remote Annunciators:
   1. Provide a flush mounted annunciator that includes an LCD display. The display must indicate the device in trouble/alarm or any supervisory device. Display the device name, address, and actual building location. The remote annunciator must duplicate functions of the FMCU for message display, fire alarm, supervisory alarm, and trouble conditions, visual and audible notification, and system reset functions. Remote annunciator must require the use of a key for accessing the reset, control and other functions.
   2. A building floor plan must be provided and mounted (behind Plexiglass or similar protective material) at the annunciator location. The floor plan must indicate all rooms by name and number including the locations of stairs and elevators. The floor plan must show all devices and their programmed address to facilitate identification of their physical location from the LCD display information.

E. Addressable Interface Devices: The initiating device being monitored must be configured as a Class "B" initiating device circuits. The module must be listed as compatible with the control unit. The module must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. Monitor module must contain an integral LED that flashes each time the monitor module is polled and is visible through the device cover plate. Pull stations with a monitor module in a common backbox are not required to have an LED. Modules must be listed for the environmental conditions in which they will be installed.

F. Addressable Control Modules: The control module must be capable of operating as a relay (dry contact form C) for interfacing the control unit with other systems, and to control door holders or initiate elevator fire service.

The module must be listed as compatible with the control unit. The indicating device or the external load being controlled must be configured as Class B notification appliance circuits. The system must be capable of supervising, audible, visual and dry contact circuits. The control module must have both an input and output address. The supervision must detect a short on the supervised circuit and must prevent power from being applied to the circuit. The control module must provide address setting means compatible with the control unit's SLC supervision and store an internal identifying code. The control module must contain an integral LED that flashes each time the control module is polled and is visible through the device cover plate. Control Modules must be listed for the environmental conditions in which they will be installed.

G. Isolation Modules:
   1. Provide isolation modules to subdivide each signaling line circuit into groups of not more than 20 addressable devices between adjacent isolation modules.
   2. Isolation modules must provide short circuit isolation for signaling line circuit wiring.
   3. Power and communications must be supplied by the SLC and must report faults to the Fire Alarm Control Unit.
   4. After the wiring fault is repaired, the fault isolation modules must test the lines and automatically restore the connection.

H. Initiating Devices:
   1. Addressable Systems:
      a. Addressable Devices: Individually identifiable by addressable fire alarm control unit.
      b. Provide suitable addressable interface modules as indicated or as required for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
   2. Manual Pull Stations:
      a. Metal or plastic, semi-flush mounted, single-action, addressable manual stations that are not subject to operation by jarring or vibration. Stations must be equipped with screw terminals for each conductor.
      b. Finish: red with molded raised lettering operating instructions of contrasting color.
      c. Stations that require the replacement of any portion of the device after activation are not permitted.
   3. Smoke Detectors:
      a. Addressable: the detector address must identify the particular unit, its location within the system, and its sensitivity setting. Detectors must be of the low voltage type rated for use on a 24 VDC system.
      b. Finish: white, unless noted otherwise on plans.
      c. Photoelectric smoke detectors utilizing the photoelectric light scattering principle for operation in accordance with UL 268.
      d. Self-restoring type that do not require any readjustment after actuation at the Fire Alarm Control Unit to restore them to normal operation. The detector must have a visual indicator to show actuation.
      e. Vibration must have no effect on the detector's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen must not inhibit the movement of smoke particles into the chamber.
      f. Provide twist lock bases with screw terminals for each conductor. The detectors must maintain contact with their bases without the use of springs.
      g. Provide a smoke detector at every location of a fire alarm control or annunciator unit.
   4. Duct Smoke Detectors:
      a. Duct-mounted addressable photoelectric smoke detectors consisting of a smoke detector, as specified in paragraph Spot Type Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry must be mounted in a metallic or plastic enclosure exterior to the duct. Detectors must be listed for operation over the complete range of air velocities, temperature and humidity expected at the detector when the air-handling system is operating. Detectors must be powered from the Fire Alarm Control Unit.
         1) Duct smoke detectors for use at fire smoke dampers must be rated down to 0 CFM air flow.

b. Sampling tubes must run the full width of the duct. The duct detector package must conform to the requirements of NFPA 90A, UL 268A, and must be listed for use in air-handling systems. The control functions, operation, reset, and bypass must be controlled from the Fire Alarm Control Unit.
c. Lights to indicate the operation and alarm condition must be visible and accessible with the unit installed and the cover in place. Remote test switches and indicators must be provided for each detector and installed at a readily accessible location; location to be determined in the field. Remote indicators as well as the affected fan units must be properly identified in etched plastic placards.
d. Detectors must provide for control of auxiliary contacts that provide control, interlock, and shutdown functions specified in 23 0913 - Instruments and Control Elements. Auxiliary contacts provide for this function must be located within 3 feet of the controlled circuit or appliance. The auxiliary contacts must be supplied by the fire alarm system manufacturer to ensure complete system compatibility.
e. When installed in an unconditioned space, provide NEMA 4X weatherproof duct housing for the applicable duct smoke detector. The enclosure shall provide for the circulation of conditioned air around the internally mounted addressable duct sensor housing to maintain the sensor housing at its rated temperature range. The housing shall be UL 268A listed.
f. When used at fire smoke dampers, rated down to 0 CFM air flow.

5. Heat Detectors:
   a. Addressable and designed for detection of fire by combination fixed temperature and rate-of-rise principle in accordance with UL 521. The alarm condition must be determined by comparing detector value with the stored values.. Detectors located in areas subject to moisture, exterior atmospheric conditions, or hazardous locations as defined by NFPA 70, must be types approved for such locations.
      1) Combination Fixed-Temperature and Rate-of-Rise Detectors: Detectors must be surface mounted in the vertical orientation and supported independently of wiring connections. Detectors must be self-resetting. Detector must operate at 135 degrees F. Detector must feature rate compensation. Detectors rated to operate at 135 degrees F must not respond to momentary temperature fluctuations less than 30 degrees F per minute between 60 and 100 degrees F.
      2) Rate Compensating Detectors: Detector backbox must be surface mounted in the vertical orientation and supported independently of wiring connections. Detectors must be self-restoring and hermetically sealed.
6. Carbon Monoxide Detectors:
   a. Analog/addressable carbon monoxide (CO) detectors must be listed to UL 2075 and set to respond to the sensitivity limits of UL 2034. Carbon monoxide detectors must be listed for use with fire alarm control units. Detectors must be surface mounted in the vertical orientation and supported independently of wiring connections. Detectors must be self-restoring. For Fire Alarm Control Unit with no listed compatible addressable CO detectors, provide listed 4-wire detectors. Detector must be provided with an LED status indicator.
   b. Where 4-wire CO detectors are necessary, each 4-wire CO detector must be individually monitored via addressable interface modules for alarm and off normal/trouble conditions (including loss of power to the individual detector). Power circuits for 4-wire CO detectors must be dedicated to powering the CO detectors only. Battery powered and 120 VAC powered detectors are prohibited.
   c. Wiring connections must be made by means of screw terminals and detectors must be equipped with trouble relays. Detectors must be able to mount a single-gang electrical box.
   d. A trouble condition at an individual CO detector must not affect any other CO detectors. CO detectors must be powered by the Fire Alarm Control Unit.
   e. Detectors must be provided with a means to test CO gas entry into the CO sensing cell.

I. Notification Appliances:
   1. Housing Color: White.
   2. Marking: "ALERT", raised lettering painted to contrast device base color.
   3. Horns:

a. Piezoelectric type horn shall be listed to UL 464.
b. Minimum sound pressure level of 85 dBA @ 24VDC.
c. Construction: sealed-back and installable on standard 4-inch square electrical boxes, without the use of special adapter or trim rings.

4. Speakers:
a. Conforming to the applicable requirements of UL 464 and UL 1480.
b. High-fidelty, high-efficiency speaker for voice annunciation, rated for maximum output at minimum power across a frequency range of 400 Hz to 4,000 Hz.
c. Construction: sealed-back and installable on standard 4-inch square electrical boxes, without the use of special adapter or trim rings.
d. Six (6) different sound output levels and operate with audio line input levels of 70V and 25V, by means of selectable tap settings.
1) Interior speaker tap settings must include taps of 1/4, 1/2, 1, and 2 watt, at a minimum.
2) Exterior speakers must be multi-tapped with no more than 15 watt maximum setting.
e. All inputs must be polarized for compatibility with standard reverse polarity supervision of circuit wiring via the Fire Alarm Control Unit.

5. Strobes:
a. Conforming to the applicable requirements of UL 1638, UL 1971, and the Architectural Barriers Act (ABA).
b. LED or xenon flash tubes with ajustable light level, minimum of 15 candela based on the UL 1971 test.
c. One (1) flash per second, visible above and below the strobe and from a 90 degree angle on both sides of the strobe.
d. Strobes used for Fire Alarm: clear high intensity optic lens.

J. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.

K. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
1. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.
2. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.
3. Signaling Line Circuits: Provide surge protection at each point where circuit exits or enters a building, rated to protect applicable equipment.

L. Locks and Keys: Deliver keys to Owner.
1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type

M. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
2. Provide one for each control unit where operations are to be performed.
3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
4. Provide extra copy with operation and maintenance data submittal.

N. Storage Cabinet for Spare Parts and Tools: Steel with baked enamel finish, size appropriate to quantity of parts and tools.
1. Padlock eye and hasp for lock furnished by Owner.
2. Locate as directed by Owner.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and Contract Documents.

B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.

C. Obtain Owner's approval of locations of devices, before installation.

D. Install instruction cards and labels.
E. Wiring Method: Unless otherwise indicated, use cables (not in conduit).
    1. Use suitable listed cables in wet locations, including underground raceways.
    2. Use suitable listed cables for vertical riser applications.
    3. Use listed plenum rated cables in spaces used for environmental air.
    4. Install wiring in conduit .
        a. Where exposed to damage.
    5. Conduit: Comply with Section 26 0533.13.
    6. Conceal all cables unless specifically indicated to be exposed.
    7. Route exposed cables parallel or perpendicular to building structural members and surfaces.
F. Voice Annunciation Messaging: provide pre-recorded messages for the following events. Messages must be recorded professionally utilizing standard industry methods in a professional female voice. Message and tone volumes must both be at the same decibel level. Messages recorded from the system microphone are not acceptable. A 1000 Hz tone (as required by NFPA 72) must precede messages. Messages must be similar to the following unless facility-specific messages are required. Message scripts must be submitted to owner for approval prior to final programming.
    1. Emergency Evacuation: "May I have your attention please. May I have your attention please. This is an emergency evacuation event. Please exit the building by the nearest exit."
    2. Fire Alarm: "May I have your attention please. May I have your attention please. A fire emergency has been reported in the building. Please exit the building by the nearest exit."
    3. Carbon Monoxide: "May I have your attention please. May I have your attention please. Carbon monoxide has been detected in the building. Please exit the building by the nearest exit."
    4. Test: "May I have your attention please. May I have your attention please. This is a test of the building alert system. Please continue your normal activities. This is only a test."
    5. All Clear: "May I have your attention please. May I have your attention please. An all clear has been issued. Please resume your normal activities."
    6. Lockdown: "May I have your attention please. May I have your attention please. This is a building safety announcement. Please listen for further instruction."
    7. Inclement Weather: "May I have your attention please. May I have your attention please. This is a weather announcement. Please listen for further instruction."

3.02 INSPECTION AND TESTING FOR COMPLETION

A. Notify Owner 7 days prior to beginning completion inspections and tests.
B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
E. Provide all tools, software, and supplies required to accomplish inspection and testing.
F. Perform inspection and testing in accordance with Section 3.03 - Minimum System Tests, NFPA 72, and requirements of local authorities; document each inspection and test.
G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
H. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.
    1. Record all system operations and malfunctions.
    2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
    3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
    4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.03 MINIMUM SYSTEM TESTS

A. System Tests: test the system in accordance with the procedures outlined in NFPA 72:

1. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The test results must be record and submitted with O&M manuals at closeout.
2. Verify the absence of unwanted voltages between circuit conductors and ground. The tests must be available at the final system test.
3. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.
4. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke detectors must be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors must comply with the requirements of NFPA 72 except disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision must be tested at each device.
5. Carbon Monoxide Detector Tests: Carbon monoxide detectors must be tested in accordance with NFPA 72 and the manufacturer's recommended calibrated test method.
6. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.
7. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.
8. Determine that the system is operable under trouble conditions as specified.
9. Visually inspect wiring.
10. Test the battery charger and batteries.
11. Verify that software control and data files have been entered or programmed into the Fire Alarm Control Unit. Hard copy records of the software must be provided to the Owner at closeout.
12. Verify that red-line drawings are accurate.
13. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.
14. Measure voltage readings for circuits to ensure that voltage drop is not excessive.
15. Disconnect the verification feature for smoke detectors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke detectors must be conducted using real smoke or the use of canned smoke which is permitted.
16. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.
17. Verify the documentation cabinet is installed and contains all as-built shop drawings, product data sheets, design calculations, site-specific software data package, and all documentation required by paragraph titled "Test Reports".

B. Intelligibility Tests: Intelligibility testing of the System must be accomplished in accordance with NFPA 72 for Voice Evacuation Systems, and ANSI/ASA S3.2.
   1. Intelligibility Requirements: Verify intelligibility by measurement after installation.
   2. Ensure that a CIS value greater than the required minimum value is provided in each area where building occupants typically could be found. The minimum required value for CIS is 0.8. Rounding of values is permitted.
   3. Areas of the building provided with hard wall and ceiling surfaces (such as metal or concrete) that are found to cause excessive sound reflections may be permitted to have a CIS score less than the minimum required value if approved by the local authority having jurisdiction, and if building occupants in these areas can determine that a voice signal is being broadcast and they must walk no more than 33 feet to find a location with at least the minimum required CIS value within the same area.
   4. Areas of the building where occupants are not expected to be normally present are permitted to have a CIS score less than the minimum required value if personnel can determine that a voice signal is being broadcast and they must walk no more than 50 feet to a location with at least the minimum required CIS value within the same area.
   5. Take measurements near the head level applicable for most personnel in the space under normal conditions (e.g., standing, sitting, sleeping, as appropriate).
   6. The distance the occupant must walk to the location meeting the minimum required CIS value must be measured on the floor or other walking surface as follows:

a. Along the centerline of the natural path of travel, starting from any point subject to occupancy with less than the minimum required CIS value.
b. Curving around any corners or obstructions, with a 12 inches clearance there from.
c. Terminating directly below the location where the minimum required CIS value has been obtained.

7. Use commercially available test instrumentation to measure intelligibility as specified by NFPA 72 as applicable. Use the mean value of at least three readings to compute the intelligibility score at each test location.

3.04 OWNER PERSONNEL INSTRUCTION

A. Provide the following instruction to designated Owner personnel:
1. Hands-On Instruction: On-site, using operational system.
2. Classroom Instruction: Owner furnished classroom, on-site or at other local facility.

B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
1. Initial Training: 1 session pre-closeout.

C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
1. Initial Training: 1 session pre-closeout.

D. Detailed Operation: Two-hour sessions for engineering staff; assume NICET level I qualifications or equivalent; combination of classroom and hands-on:

E. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.05 CLOSEOUT

A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
1. Be prepared to conduct any of the required tests.
2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
3. Have authorized technical representative of control unit manufacturer present during demonstration.
4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
5. Repeat demonstration until successful.

B. Occupancy of the project will not occur prior to Substantial Completion.

C. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
1. Specified diagnostic period without malfunction has been completed.
2. Approved operating and maintenance data has been delivered.
3. Spare parts, extra materials, and tools have been delivered.
4. All aspects of operation have been demonstrated to Owner.
5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
6. Occupancy permit has been granted.
7. Specified pre-closeout instruction is complete.

END OF SECTION

SECTION 32 9300
PLANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preparation of subsoil; final fine grading.

B. Topsoil bedding.

C. New trees and plants.

D. Mulch and Fertilizer.

E. Landscape fabric.

F. Tree Pruning.

1.02 RELATED REQUIREMENTS

A. Section 31 2324 - Building Fill: Topsoil material.

B. Section 02810 - Irrigation System.

1.03 REFERENCE STANDARDS

A. ANSI A300 Part 1 - American National Standard for Tree Care Operations -- Tree, Shrub and Other Woody Plant Maintenance -- Standard Practices; 2008.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

1.05 QUALITY ASSURANCE

A. Nursery Qualifications: Company specializing in growing and cultivating the plants with three years documented experience.

B. Installer Qualifications: Company specializing in installing and planting the plants with three years experience.

C. Tree Pruning: Comply with ANSI A300 Part 1.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

B. Protect and maintain plant life until planted.

C. Deliver plant life materials immediately prior to placement. Keep plants moist.

1.07 FIELD CONDITIONS

A. Do not install plant life when ambient temperatures may drop below 35 degrees F (2 degrees C) or rise above 90 degrees F (32 degrees C).

B. Do not install plant life when wind velocity exceeds 30 mph (48 k/hr).

1.08 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide one year warranty.

C. Warranty: Include coverage for one continuous growing season; replace dead or unhealthy plants.

D. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

PART 2 PRODUCTS

2.01 SOIL MATERIALS

A. Topsoil: Excavated from site.

2.02 SOIL AMENDMENT MATERIALS

A. Fertilizer: Containing fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, to the following proportions:.
   1. Nitrogen: 10 percent.
   2. Phosphoric Acid: 6 percent.
   3. Soluble Potash: 4 percent.

B. Peat Moss: Shredded, loose, sphagnum moss; free of lumps, roots, inorganic material or acidic materials; minimum of 85 percent organic material measured by oven dry weight, pH range of 4 to 5; moisture content of 30 percent.

C. Water: Clean, fresh, and free of substances or matter that could inhibit vigorous growth of plants.

2.03 MULCH MATERIALS

A. Mulching Material: Hardwood species wood shavings, free of growth or germination inhibiting ingredients.

2.04 ACCESSORIES

A. Wrapping Materials: Burlap.

B. Stakes: Softwood lumber, pointed end.

C. Cable, Wire, Eye Bolts and Turnbuckles: Non-corrosive, of sufficient strength to withstand wind pressure and resulting movement of plant life.

D. Plant Protectors: Rubber sleeves over cable to protect plant stems, trunks, and branches.

E. Landscape Fabric: Professional grade 5 oz. as manufactured by DeWitt Corporation, Sykeston, Missouri or approved equal. Install in all planting beds according to manufacturer's recommendation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that prepared subsoil and planters are ready to receive work.

B. Saturate soil with water to test drainage.

3.02 PREPARATION OF SUBSOIL

A. Prepare subsoil to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated subsoil.

C. Scarify subsoil to a depth of 3 inches (75 mm) where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.

D. Dig pits and beds 6 inches (150 mm) larger than plant root system.

3.03 PLACING TOPSOIL

A. Spread topsoil to a minimum depth of 4 inches (100 mm) over area to be planted. Rake smooth.

B. Place topsoil during dry weather and on dry unfrozen subgrade.

C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.

D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.

E. Install topsoil into pits and beds intended for plant root balls, to a minimum thickness of 6 inches (150 mm).

3.04 FERTILIZING

A. Apply fertilizer in accordance with manufacturer's instructions.

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B. Apply after initial raking of topsoil.

C. Mix thoroughly into upper 2 inches (50 mm) of topsoil.

D. Lightly water to aid the dissipation of fertilizer.

3.05 PLANTING

A. Place plants as indicated for review and final orientation by Architect.

B. Set plants vertical. Root flare shall be set 1" to 2" above adjacent grade.

C. Remove non-biodegradable root containers.

D. Set plants in pits directly on top of undisturbed or compacted subgrade. Remove burlap, ropes, and wires from the root ball. See details on drawings.

E. Place bare root plant materials so roots lie in a natural position. Backfill soil mixture in 6 inch (150 mm) layers. Maintain plant life in vertical position.

F. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

3.06 PLANT SUPPORT

A. Brace plants vertically with plant protector wrapped guy wires and stakes to the following:
   1. Tree Caliper: 1 inch (25 mm); Tree Support Method: 1 stake with one tie
   2. Tree Caliper: 1 to 2 inches (25 to 50 mm); Tree Support Method: 2 stakes with two ties
   3. Tree Caliper: 2 to 4 inches (50 to 100 mm); Tree Support Method: 3 guy wires with eye bolts and turn buckles
   4. Tree Caliper: Over 4 inches (100 mm); Tree Support Method: 4 guy wires with eye bolts and turn buckles

3.07 TREE PRUNING

A. Prune trees as recommended in ANSI A300 Part 1.

B. Prune newly planted trees as required to remove dead, broken, and split branches.

3.08 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 01 4000.

B. Plants will be rejected if a ball of earth surrounding roots has been disturbed or damaged prior to or during planting.

END OF SECTION

SECTION 41 2213.13
BRIDGE CRANE

PART 1 - GENERAL

1.01 SUMMARY

A. Motorized Overhead Crane System.
B. Runway beams and Bridge Beam steel.

1.02 RELATED SECTIONS

A. Section 05 1200 - Structural Steel Framing
B. Division 26 - Electrical

1.03 REFERENCES

A. ANSI B30.11
B. Crane Manufacturers Association of America, Inc. - CMAA 74.
C. Specifications for Welding Industrial and Mill Cranes - AWS D 14.1

1.04 SUBMTTALS

A. Product Data: Manufacturer's catalog information edited to indicate specific products and related accessories to be provided for this Project. Include specifications and replacement parts list.
B. Shop Drawings: Showing all details of construction, location of electrical connections, anchorages, relationship to adjoining construction. Include electrical requirements.
C. Provide calculations on structural loads for review by Structural Engineer to verify seating of runway beams.
D. Instructions: Operation and Maintenance of Overhead Crane System.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in the design and manufacture of electric chain hoists with a minimum of 10 years of documented experience.
B. Installer Qualifications: Company experienced in assembly and installation of electric chain hoists with 5 years of documented experience.
C. Comply with Crane Manufacturers Association of America, Inc (CMAA) Specification number 70 Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes.
D. Fabricate and install steel support beams, runways and bridge to tolerance required by CMAA.

1.06 WARRANTY

A. Provide manufacturer's 2 year warranty for Electric Operator.

PART 2 - PRODUCTS

2.01 UNITS

A. 10 Ton Bridge Crane with motorized trolley and electric chain hoist.

2.02 MANUFACTURERS:

A. Konecranes USA; CXTDkn10-TON: www.konecranes.com
B. Columbus McKinnon Inc: www.cmworks.com
C. EMH Cranes: www.emhcranes.com
D. Yale Hoists: www.yalehoist.com

2.03 TYPE

A. Top running, double girder crane having box girder construction or structural steel crane girder.
B. Capacity: 10 Tons
C. Duty Group: Steel structure/hoist CMAA C
D. Crane Voltage: 480V, 3 phase, 60Hz with 115V Controller
E. Hoist Speed: 10/0.98 - Dual speed
F. Trolley Travel Speed: 65 FPM
G. Hoist Lift: 20 feet.

2.04 MOTOR

A. Totally enclosed fan-cooled squirrel cage induction type with thermal overload protection. Dual speed motor. Friction clutch in the transmission between the hoist's electric motor and the load sheave. Programmable limit switches. Pendant control station, cable mounted.
B. Provide variable frequency drive for East-West and North-South movement.
C. Geared Trolley: Sized by manufacturer to work with chain hoist in configuration indicated on Drawings.

2.05 LOAD CHAIN: CASE-HARDENED GRADE 80 NICKEL-PLATED.

A. Lower Hook: Heat-treated and equipped with safety latch. 360 degree swivel.

2.06 PENDANT CONTROLLER

A. Provide 20 foot drop.
B. 115V Control
C. Field paint Bridge and Runway Beams per Section 09 9000.
    1. Color: As selected by Architect. Bridge beam to be custom color.

2.07 STEEL RUNWAYS AND BRIDGE

A. Sized by Crane Hoist manufacturer for configuration indicated on Drawings.
B. Bridge Traveling Speed: 100 FPM
C. Capacity: 10 Ton.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install cranes in accordance with manufacturer’s instructions and CMAA Specification 74.
B. Contractor shall startup and test crane system with 110 percent min. test loads, and submit documentation that crane system is in compliance with all OSHA Safety Requirements and specified Design Criteria prior to Substantial Completion.

3.02 ADJUST AND CLEAN

A. Adjustments
    1. Adjust cranes to operate to within accepted design tolerances.
    2. Lubricate all equipment in accordance with accepted manufacturer’s instructions.

3.03 CLEAN UP

A. Remove all loose materials and fillings resulting from this work.
B. Clean floor of dirt, oil and grease.
C. Remove crating and packing materials from premises.

3.04 TRAINING

A. Provide acceptable training of personnel. Quality of training shall be such that at conclusion of specified training time, each individual with their assigned category shall be capable of operating system. Training shall be videotaped for subsequent use.
B. For all types of training, associated technical data, shall be on hand at time of instruction and its use and interpretation shall be covered.
C. All instructions and materials, both oral and written, shall be in English language.

END OF SECTION

SECTION 41 2313
PAINT BOOTH

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Paint Booth – Cross Flow type.

1.02 REFERENCES

A. NFPA 33 – Standard for Spray Application Using Flammable or Combustible Materials.

1.03 SUBMITTALS

A. Product Data: Manufacturer's catalog information edited to indicate specific products and related accessories to be provided for this Project.

B. Shop Drawings: Show all details of panel construction, location of ducts and fans, electrical connections, and anchorage to floor slab.
   1. Provide calculations on Structural Loads.
   2. Provide calculations on Air Intake and Exhaust.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in the design and manufacture of paint booths with a minimum of 10 years of documented experience.

B. Installer Qualifications: Company experienced with the assembly and installation of paint booths with 5 years of documented experience.

PART 2 – PRODUCTS

2.01 MANUFACTURERS:

A. M1M Equipment; PBCF13823FT Cross Flow Paint Booth: www.m1mequipment.com

B. RTT Engineered Solutions: www.rtsolutions.com

C. Rohner Spray Booths: www.rohnerspraybooths.com

D. Panelbuilt: www.panelbuilt.com

2.02 PAINT BOOTH

A. Cross Flow Type with standard box plenum.
   1. Panel Material: 18 gage, G90 Galvanized Steel.
   2. Size: As indicated on Drawings.
   3. Front Door Opening Dimensions: 10'-0" wide x 8'-0" tall.
   4. Personnel Door: 3'-0" x 7'-0".
   5. Lighting: 2'-0" x 4'-0" LED Light Fixtures; six each.
   6. Exhaust System: 24 inch tube axial fan.
   7. Motor: 3 HP, 3-phase.
   8. CFM: 18,660 at 1/2 S.P.
   9. Filtration: 20 inch x 20 inch Intake and Exhaust Filter Pads.
   10. Manometer/Draft Gauge: To measure pressure drop across the exhaust filters, to indicate the condition of the filters.
   11. Provide all required Hardware, and Sealants.
   12. Control Panel for Lights and Fan.

B. Coordinate Booth layout with Automatic Sprinkler System.

PART 3 – EXECUTION

3.01 PREPARATION

A. Ensure floor surface of the booth are flat and level, and of non-combustible material, that allows for safe cleaning and removal of residues.

B. Ensure exhaust plenum is located in correct position with relation to the booth.

3.02 INSTALLATION

A. Install the booth per manufacturer's written installation instructions. Provide a 3 foot clearance around the booth to adjacent partition walls.

B. Install ductwork to comply with Code required clearances; 6 foot above roof surface.

3.03 ADJUST AND CLEAN

A. After installation adjust and clean paint booth. Test and balance air flow for intake and exhaust.

3.04 TRAINING

A. Train Owner's personnel on use and maintenance of the Paint Booth and all equipment. Record training session for future viewing of new personnel, and/or provide link to manufacturer's pre-recorded video on Paint Booth model installed.

B. Provide Operation and Maintenance Manuals with Closeout Documents.

END OF SECTION