DIVISION 21 - FIRE PROTECTION INDEX

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SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE PROTECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Work Included:

1. The system shall include all fire department connections, valves, sprinklers, dry sprinklers, piping, drain risers, pressure reducing valves, cabinets, alarms as required for a complete system. Building or area will be fully sprinklered (exception only as per local code).

2. All areas will be supplied from a sprinkler riser system.

3. Areas exposed to freezing will have a dry type sprinkler system or wet system with heat trace.

4. Before any work is commenced, shop drawings shall be carefully prepared and submitted for review. It is required that the sprinkler systems be sized hydraulically in accordance with NFPA standards. Submit hydraulic calculation of each system with shop drawings showing balanced system delivery, and balanced supply and demand for the appropriate hazard class as defined in NFPA 13, latest edition accepted by local authority having jurisdiction. Such drawings and calculations must be reviewed and approved by all governing authorities, Fire Department, Owners Insurance Underwriters, Factory Mutual and/or Industrial Risk Insurers before any work is commenced at the jobsite.

5. Comply with all owner requirements and FM global requirements.

B. This Section includes general administrative and procedural requirements for fire protection installations. The administrative and procedural requirements included in this Section expand the requirements specified in Division 1:

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and the other sections of Division 21.

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

1. Sustainable Design Requirements – Division 01

2. Cast-in Place Concrete - Division 03-“Concrete”

3. Metal Fabrications - Division 05-“Metals”

4. Firestopping-Division 07 -“Thermal and Moisture Protection”

5. Flashing Wall and Roof Penetrations - Division 07 - “Thermal and Moisture Protection”

6. Sealants and Caulking - Division 07 - “Thermal and Moisture Protection”

7. Painting – Division 09 – “Finishes”

8. Division 21 Fire Protection

9. Division 22 – Plumbing

10. Division 23 – Heating, Ventilation, and Air Conditioning

11. Division 26 – Electrical

12. Excavation and Backfill – Division 31 – “Earthwork”

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Concealed: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

D. Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

E. Interior Installations: Protected from weather conditions and not subject to outdoor ambient temperatures.

F. Piping: Pipe, fittings, flanges, valves, controls, hangers, drains, insulation, and items customarily required in connection with the transfer of gaseous and fluid mediums.

G. By Other Trades: By persons or parties responsible for work at the project other than the party or parties who have been duly awarded the contract for the work of Division 21. In the event that this document is used to acquire work as part of a general construction contract the words "by other trades" shall mean by persons or parties who are not anticipated to be the sub-contractor for this trade working together with the general contractor. In this context the words "by other trades" shall not be interpreted to mean not included in the overall contract.

1.4 SUBMITTALS:

A. In accordance with Division 01, SUBMITTAL PROCEDURES, prior to purchasing any equipment or materials and prior to assembling or installing the work, the following shall be submitted for approval:

1. Scale drawings indicating insert and sleeve locations if required by Architect or Structural Engineer.

2. Scale drawings showing all piping and duct runs with sizes, elevations and appropriate indication of coordination with other trades. This submission to us shall consist of one (1) electronic file and two (2) paper prints.

3. Catalog information, factory assembly drawings and field installation drawings as required for a complete explanation and description of all items of equipment. List all manufacturers and certifications. Submit min. six (6) copies.

4. Coordination drawings for access panels and door locations

5. Welder Certificates signed by the Contractor certifying that welders comply with requirements specified under "Quality Assurance" in this section.

B. Documents will not be accepted for review unless:

1. They include complete information in accordance with local code and with the applicable sections of NFPA including 13 pertaining to appurtenances and accessories.

2. They are submitted as a complete package where they pertain to related items.

3. They are properly marked with service or function, project name, where they consist of catalog sheets displaying other items which are not applicable.

4. List of all deviations and exceptions from the specified requirements for the product is provided on the first sheet of the submittal.

5. They indicate the project name and address along with the Contractor's name, address and phone number.

6. They are properly marked with external connection identification as related to the project where they consist of standard factory assembly or field installation drawings.

C. Shop Drawing Review

1. The purpose of the review of shop drawings is to maintain integrity of the design. Unless the contractor clearly points out changes, substitutions, deletions or any other differences between the submission and the Contract Documents in writing on the Contractor's letterhead, review by the Engineer or Architect does not constitute acceptance. It is not to be assumed that the engineer has read the text nor reviewed the technical data of a manufactured item and its components except where the Vendor has pointed out differences between his product and the specified model.

2. Upon receipt of the approved manufacturers and material suppliers list, the Contractor shall immediately obtain complete Shop Drawings, Product Data and Samples and equipment and material Specification Compliance Review documents from the manufacturers, suppliers, vendors and all Division 21 Contractors, for all materials and equipment as specified herein in various sections of the specifications and shall submit data and details of such materials and equipment for review by the Architect and Engineer. Prior to submission of the Shop Drawings, Product Data and Samples to the Architect and Engineer, the Contractor shall thoroughly review the Shop Drawings, Product Data and Samples and certify they are in compliance with the Contract Documents. The Contractor shall provide a compliance review ("Compliance Review") of the applicable Drawings, Specifications and Addenda for all equipment and materials. The Compliance Review will be a paragraph by paragraph review of the Specifications with the following information marked for each Specification section paragraph or in the margin of the original Specification and any subsequent Addenda.

   a. "C": Comply with no exceptions.
   b. "D": Comply with minor deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.
   c. "E": Exception. Equipment, product or material does not comply. For each and every exception, provide a numbered footnote with reasons for each exception and suggest possible alternatives for the owner's consideration.
   d. "N/A": The specification paragraph does not apply to the proposed equipment, material or product.
   e. Unless a deviation or exception is specifically noted in the Compliance Review, it is assumed that the Contractor is in complete compliance with the Contract Documents. Deviations or exceptions taken in cover letters, subsidiary documents, by omission or by contradiction does not relieve the Contractor from being in complete compliance unless the exception or deviation has been specifically noted (explicitly, not by implication) in the Compliance Review.

3. It is the responsibility of the contractor to confirm all dimensions, quantities, and the coordination of materials and products supplied by him with other trades. Review of shop drawings containing errors does not relieve the contractor from making corrections at his expense.

4. Substitutions of equipment, systems, materials, must be coordinated by the Contractor with his own or other trades which may be involved with the item, such as, but not limited to, equipment substitutions which change electrical requirements, or hanging or support weights or dimensions.

5. Any extra charges or credits which may be generated by other trades due to substitutions will not be accepted unless the Contractor has an agreement in writing with the Owner.

6. Substitutions of equipment, systems, etc. requiring approval of local authorities must comply with such regulations and be filed at the expense of the Contractor (should filing be necessary). Substitutions are subject to approval or disapproval by the Engineer. The Contractor in offering substitutions shall hold the Owner and Engineer harmless if the substituted item is an infringement of patent held by the specified item.

7. Shop drawings shall show all data required by NFPA and Authorities having Jurisdiction.

D. Explanation of Shop Drawing Stamp

1. Reviewed - No Exception Taken: indicates that we have not found any reason why this item should not be acceptable within the intent of the contract documents.

2. Exception Taken As Noted: indicates that we have found questionable components which if corrected or otherwise explained make the product acceptable.

3. Revised and Resubmit: indicates that this item should be resubmitted for review before further processing.

4. Resubmit Specified Item: indicates that the item will not meet the intent of the Contract.

5. Incomplete - Resubmit: Indicates that the submission is not complete and ready for review by the Architect or Engineer.

6. Verified for Electrical Services: Indicates that the electrical requirements has been confirmed with the electrical contract documents.

7. Architects Approval Required: Indicates that the submission will require the Architects review.

8. Structural Approval Required: Indicates that the submission will require the Structural Engineer's review.

9. Acoustical Consultant Required: Indicates that the submission will require Acoustical Consultant review.

10. No shop drawing stamp or note shall constitute an order to fabricate or ship. Such notification can only be performed by the Project Manager for Construction, the Contractor scheduling his own work, or the Owner.

11. The Contractor is responsible for having "Reviewed" copies of shop drawings bearing the "Reviewed - No Exception Taken" stamp of the Architect/Engineer or Owner's Consultant are kept on the job site and work is implemented in the field in accordance with these documents.

12. Where information from one Contractor is required by another contractor, it is the responsibility of the contractors to exchange information and coordinate their work.

E. Maintenance Data and Operating Instructions:

1. Maintenance and operating manuals in accordance with Division 01, QUALITY REQUIREMENTS, for systems and equipment.

2. After all final tests and adjustments have been completed, fully instruct the proper Owner's Representative in all details of operation for equipment installed. Supply qualified personnel to operate equipment for sufficient length of time to assure that Owner's Representative is properly qualified to take over operation and maintenance procedures. Supply qualified personnel to operate equipment for sufficient length of time as required to meet all governing authorities in operation and performance tests.

3. Furnish required number of manuals, in bound form containing data covering capacities, maintenance of operation of all equipment and apparatus. Operating instruction shall cover all phases of control and include the following:

   a. Performance Curves: For pumps, and similar equipment at the operating conditions.

   b. Lubrication Schedule: Indicating type and frequency of lubrication required.

   c. List of Spares: Recommended for normal service requirements.

   d. Parts List: Identifying the various parts of the equipment for repair and replacement purposes.

   e. Instruction Books may be standard booklets but shall be clearly marked to indicate applicable equipment.

   f. Wiring Diagrams: Generalized diagrams are not acceptable, submittal shall be specifically prepared for this Project.

   g. Automatic Controls: Diagrams and functional descriptions.

4. Where applicable, one set of operating and maintenance instructions shall be neatly hung adjacent to the equipment concerned.

F. Product Data: For the following:

1. Transition fittings.

2. Dielectric fittings.

3. Mechanical sleeve seals.

4. Escutcheons.

G. Welding certificates submit welding certificates as specified herein.

1.5 QUALITY ASSURANCE

A. Applicator: Company specializing in piping installation with seven years minimum experience.

B. Systems, installation, equipment and materials shall conform to requirements of the local Building Code, Owners Insurance Underwriters, Factory Mutual, Industrial Risk Insurers, local Fire Department, applicable NFPA reference standards, ANSI/ASME B31.9 "Building shall be Service Piping" and all authorities having jurisdiction. Equipment and materials shall be Underwriters listed, labeled and approved as required.

C. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

D. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

3. Comply with all pipe welding requirements found in NFPA 13.

E. Products Criteria

1. All equipment and materials shall be new and without blemish or defect.

2. Asbestos

a. All equipment and materials shall be free of asbestos.

3. Electrical equipment and materials shall be products which will meet with the acceptance of the agency inspecting the electrical work. Where such acceptance is contingent upon having the products examined, tested and certified by Underwriters Laboratories or other recognized testing laboratory, the product shall be examined, tested and certified. Where no specific indication as to the type or quality of materials or equipment is indicated, a first class standard article shall be furnished.

4. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

5. It is the intent of these specifications that wherever a manufacturer of a product is specified, and the terms "other approved" or "or approved equal" or "equal" are used, the substituted item must conform in all respects to the specified item. Consideration will not be given to claims that the substituted item meets the performance requirements with lesser construction. Performance as delineated in schedules and in the specifications shall be interpreted as minimum performance. In many cases equipment is oversized to allow for pick-up loads which cannot be delineated under the minimum performance.

6. All equipment of one type shall be the products of one manufacturer.

7. Substituted equipment or optional equipment where permitted and approved, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether approved or not, shall be replaced at the Contractor's expense. Any modifications of related systems as a result of substitutions shall be made at the Contractor's expense.

8. Note that the review of shop drawings, or other information submitted in accordance with the requirements hereinbefore specified, does not assure that the Engineer, Architect, or any other Owner's Representative, attests to the dimensional accuracy or dimensional suitability of the material or equipment involved or the ability of the material or equipment involved or the mechanical performance of equipment. Review of Shop Drawings does not invalidate the plans and specifications if in conflict, unless a letter requesting such change is submitted and approved on the Engineer's letterhead.

9. Substitutions of equipment for that shown on the schedules or designated by model number in the specifications will not be considered if the item is not a regular cataloged item shown in the current catalog of the manufacturer.

1.6 DELIVERY, STORAGE, HANDLING AND PROTECTION

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Unit shall be stored and handled in accordance with manufacturer's instructions.

C. Unit shall be shipped with all listed items and control wiring factory installed unless noted on the submittals and approved prior to shipment.

D. Unit shall be shipped complete as specified. Parts for field installation shall not be shipped and stored on site without prior approval.

E. Rigging: Units shall be fully assembled. Units requiring disassembly for rigging shall be factory assembled and tested. Disassembly, reassembly and testing shall be supervised by the manufacturer's representative.

F. Unit shall be shipped with firmly attached labels that indicate name of manufacturer, model number, serial number, and plan tagging.

G. Deliver, store and handle all materials to keep clean and protected from damage.

H. Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

I. Protect flanges, fittings, and piping specialties from moisture and dirt.

J. Protect stored plastic pipes from direct sunlight and excess heat. Support to prevent sagging and bending.

K. Protect equipment and other materials from damage after installed from construction debris and other damage.

L. This trade shall be responsible for its work and equipment until finally inspected, tested and accepted. Carefully store materials and equipment which are not immediately installed after delivery to site. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing material.

M. This trade shall protect work and material of other trades from damage that might be caused by its work or workmen and make good damage thus caused.

1.7 PRECONSTRUCTION CONFERENCE PRIOR TO START OF WORK

A. Prior to commencing any Work, the CM, together with designated major Contractors, shall confer with the Architect and Engineer concerning the Work under the Construction Contract.

B. The pre-construction conference will be conducted under the leadership of the CM and will occur soon after the CM notifies the Subcontractors of contract award. The pre-construction conference will focus on items such as the expedited submittal review procedure, interface and coordination between Contractor work scope, the CM's project site rules and requirements, temporary utility requirements, CM's construction schedule, etc.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

C. Coordinate the installation of required supporting devices and set sleeves in poured in place concrete and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

E. Coordinate connection of electrical services.

F. Coordinate connection of fire protection systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

G. Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces. See paragraph titled “Separation of Work Between Trades” to determine whether access panels and doors the responsibility of the Contractor for Division 08 or the Contractor responsible for Division 21.

H. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

1.9 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for fire protection items requiring access that are concealed behind finished surfaces.

D. Provide all designating signs for shutoff valves, control valves, alarms, and the like, as required by the agencies having jurisdiction.

1.10 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 01 Section "PROJECT COORDINATION," to a scale of 3/8"=1'-0" or larger; detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. The coordination drawings shall be produced using AutoCad 2011 or later software. The design drawings will be made available on disks in AutoCad format for use as a basis for the "Coordination" drawings. These documents remain the property of Cosentini Associates and shall be used for no other purpose without expressed, written consent. The contractor shall assume all liabilities resulting from unauthorized use or modifications to the drawings.

2. Indicate the proposed locations of piping, equipment, and materials. Include the following:

a. Planned piping layout, including valve and specialty locations and valve stem movement.

b. Clearances for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.

c. Equipment connections and support details.

d. Exterior wall and foundation penetrations.

e. Fire-rated wall and floor penetrations.

f. Sizes and location of required concrete pads and bases.

g. Clearances as required by Electric Code.

3. Indicate piping loads and support points for all piping 3" and larger, racked piping, and submit to the Structural Engineer for review and approval. Indicate the elevation, location, support points, and loads imposed on the structure at support, anchor points, and size of all lines. Indicate all beam penetrations and slab penetrations sized and coordinated. Indicate all work routed underground or embedded in concrete by dimension to column and building lines.

4. Identify all equipment and systems that are installed as part of the work of this Division that by Code require seismic restraint.

5. Indicate seismic support and restraint for all piping and equipment installed as part of the work of this Division and specified under another section of Division 21

6. Identify all equipment and systems installed as part of the work of this Division that by Code does not require seismic restraint whose failure in a seismic event will cause the failure of life safety, high hazard or essential facilities systems installed as part of the work of this Division or restrained equipment and systems installed as part of the work of other Divisions.

7. The equipment and systems identified that by Code do not require seismic restraint whose failure may result in failure of equipment and systems (installed as part of the work of this Division or the restrained equipment and systems installed as part of the work of other Divisions) requiring seismic restraint due to their proximity and relative position shall be seismically restrained.

8. Indicate seismic support and restraint for equipment and system identified in 6 & 7 above.

9. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

10. Prepare floor plans, elevations and details to indicate penetrations in floors, walls and ceilings and their relationship to other penetrations and installation.

11. Prepare reflected ceiling plans to coordinate and integrate sprinkler installations, air outlets and inlets, light fixtures, communication systems components and other ceiling-mounted items.

B. Fire Protection Coordination Drawings

1. This trade shall add to Coordination Drawings prepared by the HVAC Contractor showing all of the fire protection work (equipment, piping, etc.) to be installed as part of the work of this section of the specifications.

2. The Coordination Drawings shall be prepared on electronic media (CADD) at not less than 3/8": 1'-0" scale.

3. This Trade after showing all of the fire protection work shall forward the reproducible Coordination Drawings to the Electrical Contractor.

4. The sequence of coordination drawings shall be HVAC-PLBG-FP-ELEC-GC/CM.

5. The Fire Protection Contractor shall attend a series of meetings arranged by the General Contractor/Construction Manager to resolve any real or apparent interferences or conflicts with the work of the other Contractors.

6. The Fire Protection Contractor shall then make adjustments to his work on the Coordination Drawings to resolve any real or apparent interferences or conflicts.

7. After any real or apparent interferences and conflicts have been incorporated into the Coordination Drawings, the Fire Protection Contractor shall "sign-off" the final Coordination Drawings.

8. The Fire Protection Contractor shall not install any of his work prior to "sign-off" of final Coordination Drawings. If the fire protection work proceeds prior to sign-off of Coordination Drawings, any change to the fire protection work to correct the interferences and conflicts which result will be made by the Fire Protection Contractor at no additional cost to the project.

9. Coordination Drawings are for this Contractor's and Architects use during construction and shall not be construed as replacing any shop "as-built", or Record Drawings required elsewhere in these Contract Documents.

10. Review of Coordination Drawings shall not relieve this Contractor from his overall responsibility for coordination of all work performed pursuant to the Contract or from any other requirements of the Contract.

1.11 RECORD DRAWINGS

A. Prepare record documents in accordance with the requirements in Division 01. In addition to the requirements specified in Division 01, comply with the following.

1. A complete set of "as-built" or record drawings shall be made up and delivered to the Architect.

B. The drawings shall show:

1. All work installed exactly in accordance with the original design.

2. All installed as a modification or addition to the original design.

3. The dimensional information necessary to delineate the exact location of all piping runs which are so concealed as to be untraceable by inspection through the regular means of access established for inspection and maintenance.

4. All items required by NFPA 13 for working drawings.

C. This trade shall submit the "as-built" set for approval by the building department, when required by the jurisdiction.

D. The drawings shall be produced using AutoCad 2011 or later software. The design drawings will be made available on disks in AutoCad format for use as a basis for the "as-built" drawings. These documents remain the property of Cosentini Associates and shall be used for no other purpose without expressed, written consent. The contractor shall assume all liabilities resulting from unauthorized use or modifications to the drawings. Prior to developing any "as-built" drawings, the contractor shall coordinate with the Owner and the Architect and Engineer the drawing layers, colors, etc., of the CAD drawings. "As-built" information shall be submitted as follows:

1. CAD drawing files on disks in AutoCad 2011 format.

2. Two (2) sets of printed drawings.

E. Where shop drawings have been prepared and approved, the "as-built" drawings shall be cross referenced to the respective shop drawing.

F. As-built record drawings shall include the updating of all equipment schedule sheets.

G. The record drawings shall be of legible reproducible and durable type.

H. The quantity of design drawings which are made available shall in no way be interpreted as setting a limit to the number of drawings necessary to show the required "as-built" information.

I. Progress prints of record drawings shall be submitted monthly during the construction period for Architect's approval.

J. This trade shall submit the "as-built" set for approval by the Engineer in a form acceptable to the Engineer.

K. Final acceptance of the fire protection systems by the authority having jurisdiction will not be implemented until “as-built” drawings are on site.

L. As-built/record drawings shall comply with NFPA 13, and all other applicable standards.

M. As-built drawings for filing with the Building Department (where required) shall be prepared at the same scale, in the same plan format and use the same symbols and nomenclature as the plans filed by Engineer of Record with the Building Department for “Building Permit.”

1.12 INTERPRETATION OF THE DRAWINGS AND SPECIFICATIONS

A. As used in the drawings and specifications, certain non technical words shall be understood to have specific meanings as follows:

1. "Furnish"----------Purchase and deliver to the project site complete with every necessary appurtenance and support.

2. "Install"----------Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project.

3. "Provide"----------"Furnish" and "Install".

B. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.

C. It shall be understood that the specifications and drawings are complementary and are to be taken together for a complete interpretation of the work. Where there are conflicts between the drawings and specifications or within the specifications or drawings themselves, the items of higher standard shall govern.

D. No exclusions from, or limitations, in the language used in the drawings or specifications shall be interpreted as meaning that the appurtenances or accessories necessary to complete any required system or item of equipment are to be omitted.

E. The drawings of necessity utilize symbols and schematic diagrams to indicate various items of work. Neither of these have any dimensional significance nor do they delineate every item required for the intended installations. The work shall be installed, in accordance with the diagrammatic intent expressed on the drawings, and in conformity with the dimensions indicated on final architectural and structural working drawings and on equipment shop drawings.

F. No interpretation shall be made from the limitations of symbols and diagrams that any elements necessary for complete work are excluded.

G. Certain details appear on the drawings which are specific with regard to the dimensioning and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field co-ordination for the indicated work.

H. Information as to the general construction shall be derived from structural and architectural drawings and specifications only.

I. The use of words in the singular shall not be considered as limiting where other indications denote that more than one item is referred to.

J. In the event that extra work is authorized, and performed by this trade, work shown on drawings depicting such work, and/or described by Bulletin is subject to the base building specifications in all respects.

1.13 SEPARATION OF WORK BETWEEN TRADES

A. The Specifications for the overall construction delineate various items of work under separate trade headings. The list below sets forth this delineation to the extent that it affects the Fire Protection Work.

B. In the absence of more detailed information, this list shall be taken as a specific instruction to the Fire Protection trade to include the work assigned to it.

C. Indications that the Fire Protection trade is to perform an item of work mean that it is to perform the work for its own accommodation only, except as specifically noted otherwise.

D. Oth= Divisions other than Electrical (Division 26); Mechanical (Divisions 21, 22 & 23)

Plb=Plumbing

FP=Fire Protection

Htg=Heating, Ventilating & Air Conditioning

Elec=Electrical

F=Furnished

I=Installed

P=Provided (furnished and installed)

Item	Oth	Plb	FP	Htg	Elec	Notes
Motors for fire protection equipment			p			
Motor controls for fire protection equipment			f		I	Specifications and drawings delineate detailed exceptions.
Wiring for fire protection equipment motors & motor controls					P	Specifications and drawings delineate detailed exceptions.
Temporary heat	p					
Temporary water	p					
Temporary light and power	p					

Item	Oth	Plb	FP	Htg	Elec	Notes
Temporary toilets	p					
Temporary fire protection			p			
Hoisting	p					
Rigging	p					
Bracing of building for safe rigging			p			
Cutting, chasing & patching	p					Cost where due to late installation or improper coordination of work is the responsibility of the delinquent trade
Framed slots and openings in walls decks and slabs			p			
Sleeves through slabs, decks and walls			p			
Sleeves through membraned and waterproofed slabs, decks and walls			p			
Waterproof sealing of pipes passing through sleeves			p			
Waterproof sealing of sleeves through membraned and water-proofed slabs, decks and walls			p			
Fireproof sealing of excess openings in slabs, decks & fire rated walls			p			

Item	Oth	Plb	FP	Htg	Elec	Notes
Sprinkler piping and heads, and valves			p			
Excavation and backfill inside buildings	p					
Excavation and backfill outside buildings	p					
Keeping site and excavations free from water during construction	p					To accommodate the overall project
Fastenings			p			
Supports			p			
Concrete encasement of underground runs	p					
Base flashing for all piping penetrating roof	p					
Cap flashing for all piping penetrating roof			p			
Concrete foundations, pads and bases	p					Fire Protection Trade to furnish sizes and locations.
Concrete (masonry) pits	p					Fire Protection Trade to furnish sizes and locations.
Pit frames and covers	p					Fire Protection Trade to furnish sizes and locations.
Trenches in building foundation	p					Fire Protection Trade to furnish sizes and locations.
Field touch up painting of damaged shop coats			p			

Item	Oth	Plb	FP	Htg	Elec	Notes
Prime coating hangers & supports			p			
Rustproofing field cut and assembled iron supporting frames and racks			p			
Finished painting	p					
Finished Wall and Ceiling Access Doors and Supporting Frames	P					Supplying list locating all required access doors (none to be less than 16" x 16") included in Fire Protection.
Finished Wall and Ceiling Access Doors and Supporting Frames	I		f			Fire Protection Contractor shall locate the doors on approved shop drawings and shall be held responsible for the accessibility of all concealed valves, controls, equipment, etc.
Cat walks to mechanical equipment	p					Fire Protection contractor to supply list of locations.
Ladders to mechanical equipment and fire protection valves.	p					Fire Protection contractor to supply list of locations.
Fire extinguishers	p					
Fire extinguishers cabinets	p					
Rubbish removal			p			Where one trade furnishes and another installs, the installing trade removes the shipping and packing materials which accumulate.
Special tools for equipment maintenance			p			

Item	Oth	Plb	FP	Htg	Elec	Notes
Fire service from street main, including curb valve and box, double check valve and OS&Y valve connection inside building			p			
Electric heating cables for pipe tracing					p	

E. The Fire Protection Trade is required to supply all necessary supervision and coordination information to any other trades who are to supply work to accommodate the Standpipe and Sprinkler installation.

F. Where the Fire Protection Trade is required to install items which it does not purchase, it shall include for such items:

1. The co-ordination of their delivery.

2. Their unloading from delivery trucks driven in to any designated point on the property line at grade level.

3. Their safe handling and field storage up to the time of permanent placement in the project.

4. The correction of any damage, defacement or corrosion to which they may have been subjected.

5. Their field assembly and internal connection as may be necessary for their proper operation.

6. Their mounting in place including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt them to architectural and structural conditions.

7. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

1.14 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

Reference	Definition
ASTM	American Society for Testing Materials

NFPA	National Fire Protection Association
UL	Underwriters Laboratories, Inc.
NEMA	National Electrical Manufacturers Assn.
FM	Factory Mutual
USAS	United States of America Standards Institute
ANSI	American National Standards Institute
AWWA	American Water Works Association
F.S.	Federal Specifications, U.S. Government
I.S.O.	Insurance Services Organization

1.15 CODES, PERMITS AND INSPECTIONS

A. All work shall meet or exceed the latest requirements of all national, state, county, municipal and other authorities exercising jurisdiction over construction work at the project.

B. All required permits, approval and inspection certificates shall be obtained, paid for, and made available at the completion of the work, by the Fire Protection Contractor.

C. Any portion of the work which is not subject to the approval of an authority having jurisdiction, shall be governed by the applicable sections of the overall National Fire Code, as published by the National Fire Protection Association (NFPA).

D. Installation procedures, methods, and conditions shall comply with the latest requirements of The Federal Occupational Safety and Health Act (OSHA).

E. The Fire Protection Contractor shall be responsible for the installation and multiple filings until the installation has been approved by the authorities having such jurisdiction at the completion of the project.

F. At the completion of the project, the fire protection contractor shall prepare and submit to the building department a set of "as-built" record drawings for approval, in a form acceptable to the building department.

1.16 SUSTAINABLE DESIGN REQUIREMENTS

A. Implement practices and procedures to meet the project's environment goals which include achieving LEED (Leadership in Energy and Environmental Design) green building certification. Ensure that the requirements related to these goals, as defined in Division 01 and this section are implemented to the fullest extent. It is the Contractor's responsibility to refer to the applicable LEED version being followed for this project and comply with the specific requirements. The Contractor shall inform the Architect and LEED Consultant should proposed substitutions or changes affect the stated LEED requirements. Substitutions, or other changes to the work proposed by the contractor or their Subcontractors, shall not be allowed without express written consent of the Architect and LEED Consultant.

1.17 GUARANTEES AND CERTIFICATIONS

A. All work shall be guaranteed to be free from leaks or defects. Any defective materials or workmanship as well as damage to the work of all trades resulting from same shall be replaced or repaired as directed for the duration of stipulated guaranteed periods.

B. The duration of guarantee periods following the date of beneficial use of the system shall be one year. Beneficial use is defined as operation of the system to obtain its intended use.

C. The date of acceptance shall be the date of the final payment for the work or the date of a formal notice of acceptance, whichever is earlier.

D. Certification shall be submitted attesting to the fact that specified performance criteria are met by all items of Fire Protection equipment.

1.18 EXAMINATION OF SITE AND CONTRACT DOCUMENTS

A. Before submitting prices or beginning work, thoroughly examine the site and the Contract Documents.

B. No claim for extra compensation will be recognized if difficulties are encountered which examination of site conditions and Contract Documents prior to executing Contract would have revealed.

1.19 WORKMANSHIP

A. The entire work provided in this Specification shall be constructed and finished in every respect in a workmanlike and substantial manner.

B. It is not intended that the drawings shall show every pipe, fitting and appliance. Fire Protection Contractor shall furnish and install all such parts as may be necessary to complete the systems in accordance with the best trade practice.

C. Keep other trades fully informed as to shape, size and position of all openings required for apparatus and give full information to the General Contractor and other trades in a timely manner so that all openings may be built in advance.

D. In case of failure on the part of the Fire Protection Contractor to give proper and timely information as required above, he shall do his own cutting and patching or have some done by the General Contractor, but in any case, without extra expense to the Owner.

E. Obtain detailed information from the manufacturers of apparatus as to the proper method of installing and connecting same. Obtain all information from the General Contractor and other trades which may be necessary to facilitate work and completion of the whole project.

1.20 CONTINUITY OF SERVICES

A. Do not interrupt existing services without Owner's Representative approval.

B. Schedule interruptions in advance, according to Owner's Representative instructions. Submit, in writing, with request for interruption, methods proposed to minimize impact on Owner's operations. Interruptions shall also be coordinated with the local Fire Department.

C. Interruptions shall be scheduled at such times of day and work to minimize impact on Owner's operations.

1.21 FIRE FLOW TEST

A. The Fire Protection Contractor shall perform up-to-date fire flow tests indicating the static and residual pressures in the water mains used for fire service with certified flow volumes at time of test. Tests must be conducted at or near peak demand times of day.

B. This data must be used in conjunction with Contractor's hydraulic calculations to submit any revised Fire Pump Specifications listing new GPM flow required, head generated, horsepower requirements, etc., for approval by the Engineer. Include calculations for dynamic (rated) and static (churn) flow conditions.

1.22 UTILITY SERVICES

A. This contractor will install sprinkler services to a point 5'-0" beyond the building wall and connect to all services provided by the site utility contractor. Coordinate adaptable materials with Site Contractor.

B. Services shall be installed in accordance with the provisions of the local authorities having jurisdiction and the Sprinkler Trade shall obtain all necessary approvals.

C. It is intended that directly or indirectly, all required metered water, services shall be installed ready for operation without additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified. Substitutions will not be permitted unless approved by the Engineer.

2.2 TOOLS AND LUBRICANTS:

A. Furnish special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.

B. Lubricants: A minimum of one quart of oil, and one pound of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

2.3 FIRESTOPPING:

A. Refer to Division 08 titled "Thermal and Moisture Protection" for fire-stopping requirements.

B. Contractor responsible for the work of Division 21 shall be responsible for fire-stopping of all work installed as part of the work of Division 21.

C. Firestopping system must be U.L. listed.

D. All spaces between pipes and their respective sleeves shall be packed full depth with mineral wool, or other equally fire resistant material, and compressed firmly in place. Fiberglass shall not be used. Sleeve clearances shall not exceed ½ inch between pipes (or ducts) and sleeves. Use individual sleeves for each pipe or duct. Before escutcheons are attached caulking must be available for inspection and notification should be made.

E. Fire Stopping material and installed configuration shall maintain the fire rating of the penetrated wall, floor or ceiling.

2.4 FOUNDATIONS, PADS AND VIBRATION ISOLATION:

A. General

1. All equipment, piping, etc., mounted on/or suspended from approved foundations and supports, as specified, as shown on the drawings.

2. All concrete foundations and supports (and required reinforcing and forms) will be provided by the Contractor responsible for the work of Division 03. This trade shall furnish shop drawings showing adequate concrete reinforcing steel details and templates for all concrete foundations and supports, and all required hanger bolts and other appurtenances necessary for the proper installation of his equipment. Although another trade will complete all concrete work, all such work shall be shown in detail on the shop drawings, prepared by this trade, which drawings shall be submitted showing the complete details of all foundations including necessary concrete and steel work, etc.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

A. Comply with requirements of Division 02 titled "Existing Conditions"

B. This contractor shall provide all required labor, materials, equipment and perform all operations for complete demolition, removal and relocation of the existing work as indicated on the drawings and/or as specified or described and/or as required for the performance of the general work under this contract.

C. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.

1. Piping to be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

2. Piping to be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.

3. Equipment to be Removed: Disconnect and cap services and remove equipment.

4. Equipment to be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

5. Equipment to be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

D. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

E. All removed equipment and material shall be removed from the project site.

F. Unless otherwise specifically specified, include all cutting and patching of existing floors, walls, partitions and other materials in the existing building. The Contractor shall restore these areas to original conditions.

G. Provide alteration work as shown on drawings or described herein. If asbestos is present or suspected to be present inform the Owner in writing so that such removal can be carried out by qualified personnel hired by the Owner. Do not commence demolition until such work has been completed.

3.2 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 01; Section titled "Execution" covering "cutting and patching." In addition to the requirements of Division 01 of this Specification, the following requirements shall apply:

1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work.

2. Remove and replace defective Work.

3. Remove and replace Work not conforming to requirements of the Contract Documents.

4. Remove samples of installed Work as specified for testing.

5. Install equipment and materials in existing structures.

6. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

C. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.

D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

F. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

1. Refer to Division 01 Section titled “References” for definition of "experienced Installer."

G. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

1. Refer to Division 01 Section titled “References” for definition of "experienced Installer."

3.3 GROUT

A. Install nonmetallic nonshrink grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions.

B. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

C. Clean surfaces that will come into contact with grout.

D. Provide forms for placement of grout, as required.

E. Avoid air entrapment when placing grout.

F. Place grout to completely fill equipment bases.

G. Place grout on concrete bases to provide a smooth bearing surface for equipment.

H. Place grout around anchors.

I. Cure placed grout according to manufacturer's printed instructions.

3.4 INSTALLATION

A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.

B. All threads on valves, fire department connections, and other equipment to which local fire department could attach hose shall be provided with hose thread to suit local fire department.

C. All equipment and materials suitable and rated for system water working pressure.

D. Color finish of valve handles, fire department caps and plugs, etc., as required by local fire department.

E. The drawings and information included in this specification are given as a guide only, and they therefore do not relieve this Contractor from providing all work and equipment necessary to complete the installation according to the requirements of Local Building Code, Owners Underwriters, N.F.P.A. and all other governing authorities.

F. The arrangement, positions and connections of pipes, drains, valves, etc., shown on the drawings shall be taken as a close approximation and while they shall be followed as closely as possible, the right is reserved by the Architect and/or Design Engineer to change the locations, to accommodate any conditions which may arise during the progress of the work without additional compensation to this contractor for such changes, provided that the changes are requested prior to the installation of this Contractor's work. The responsibility for accurately laying out the work rests with this Contractor. Should it be found out that any of his work is so laid out that interferences will occur, he shall also report that to the Architect before installation.

G. The Architect and/or Design Engineer reserves the right to reject any and all work not in accordance with the reviewed shop drawing.

H. Whether or not the system shown on the Contract Drawings meets the requirements of the National Fire Protection Association, these specifications require the furnishing and installation of fire protection systems complete in all details and in accordance with local code and the standards of the National Fire Protection Association.

3.5 PROTECTION AND CLEANING:

A. Cleaning of Piping System (General)

1. During construction, properly cap, plug and cover all openings in pipe, lines and equipment nozzles so as to prevent the entrance of sand, dirt, and foreign matter. Each system of piping shall be flushed (for the purpose of removing grit, dirt, sand, and foreign matter from the piping), in accordance with NFPA requirements for as long a time as is required to thoroughly clean the systems.

B. Adjusting (General)

1. After the entire installation has been completed, make all required adjustments to automatic controls, pressure reducing valves, etc., until all performance requirements are met.

C. All bearings of all equipment shall be oiled or greased as recommended by the manufacturer, after installation.

D. The alignment of each centrifugal pump shall be checked and each pump shall be properly aligned after the pumps are placed in service. Mechanical seals and shaft sleeves shall be replaced by this Contractor without charge in the event that unusual wear or faulty operation occurs during the guarantee period.

E. Cleaning (General)

1. Upon completion of the work, all equipment shall be thoroughly cleaned, polished and left in first class condition for final acceptance.

3.6 EXCAVATION AND BACKFILL

A. The excavation and backfill will be done by the General Contractor. The fire protection trade shall be responsible for the coordination of trench routing, slop and elevation.

B. Provide all excavation and backfill required for the fire protection work.

C. Instructions:

1. Trenches shall be excavated so that pipe can be laid to the alignment and depth indicated on the drawings, and shall be excavated only so far in advance of pipe laying as approved.

2. Width of trenches shall be held to a minimum consistent with the type of material encountered and the size of the pipe being laid, but the width at the top of the pipe shall not be more than 2'-0" plus outside diameter of pipe. Excavation for manholes and other accessories shall have 12" minimum and a 24" maximum clearance on all sides.

3. Before fill or backfilling commences, all trash, debris and other foreign material shall be removed from trenches to be backfilled by this Trade. Fill material shall be free from timber, rocks 3" or larger, organic material, frozen material, and other unsuitable material as determined by the Architect. Filling shall not be done in freezing weather, unless specifically approved. No filling shall be done when material already in place is frozen.

4. In filling around pipe, deposit backfill material in successive horizontal layers not exceeding 6" in thickness before compaction. Compact each layer thoroughly by means of approved mechanical tampers. Take special care to obtain compaction under pipe haunches. Deposit backfill adjacent to pipes on both sides to approximately same elevation at the same time. Continue this method of filling and compacting until backfill is at least 18" above top of pipe.

5. Backfilling for the remainder of pipe trenches to subgrades of paved or landscaped areas shall be done by mechanical tamping and rolling equipment, except that the use of such equipment is prohibited when said use may result in damage to pipelines or structures.

6. Backfill shall be moistened as necessary for proper compaction. Water settling of fill will not be permitted.

7. Complete backfilling of pipe trenches as soon as possible after the pipe is laid and tested.

8. Existing pavements, roadways, walkways, curbs and landscaped areas disturbed during the progress of the excavation and backfill work shall be restored to their original condition at no additional cost to the Owner.

9. Backfill shall be compacted to a minimum of 90% of modified AASHO maximum density as defined by ASTM D-1557. Any layer of fill, or portion thereof, which is not compacted to the required density shall be recompacted until the specified density is achieved, or the layer shall be removed.

3.7 ARCHITECTURAL COORDINATION AND SAMPLES

A. All devices and appurtenances which are to be installed in all finished areas must be coordinated with the Architect for final approval as it relates to location, finish, materials, color, texture, etc.

B. Submit samples of all materials requested by the Architect.

C. Samples shall be prepared and submitted with all postage and transportation costs paid by the Contractor submitting same. Label each sample with identifying numbers and titles.

D. Submit samples of:-

1. All exposed to view items such as sprinkler heads, etc.

3.8 SCHEDULE

A. See schedule on the drawings for manufacturer type and model numbers of the equipment listed below:
1. Fire department connections (flush) or (sidewalk type). **

2. Pressure reducing valves.
3. Sprinklers.
4. Automatic ball drips.
5. Valves - OS& Y
6. Check and double check valves.

3.9 ACCESS DOORS IN FINISHED CONSTRUCTION

A. Access doors as required for operation and maintenance of concealed equipment, valves, controls, etc. will be provided as part of the work of Division 08.

B. This Contractor is responsible for access door location, size and its accessibility to the valves, controls, equipment, etc. being served.

C. Coordinate and prepare a location, size, and function schedule of access doors required and deliver to a representative of the Contractor for Division 08.

D. Furnish and install distinctively colored buttons in finished ceiling.

E. Access doors shall be of ample size to perform proper maintenance on concealed equipment, valves, controls, etc. but shall not be less than a minimum of 18" x 18".

F. Construct doors and frames to comply with the requirements of the NFPA and Underwriters Laboratories Inc. for fire rating. Install UL label on each door in a non-exposed location unless otherwise required by the local authority having jurisdiction.

3.10 DRIP PANS

A. Examine the drawings and in cooperation with the Electrical Trade confirm the final location of all electrical equipment to be installed in the vicinity of piping. Plan and arrange all overhead piping no closer than two feet from a vertical line to electric motors and controllers, switchboards, panelboards, or similar equipment. Piping is not permitted in Electric Equipment, Transformer, Switch Gear, Telephone Rooms. Except as required by the authority having jurisdiction to provide fire suppression.

B. Where the installation of piping does not comply with the requirements of foregoing paragraph, the piping shall be relocated.

C. Furnish gutters as follows:

1. Provide and erect a gutter of 16 ounce cold rolled copper or 18 gauge galvanized steel, under every pipe which is within 2'-0" from a vertical line to any motor, electrical controllers, switchboards, panel boards, or the like.

2. Each gutter shall be reinforced, rimmed, soldered and made watertight, properly suspended and carefully pitched to a convenient point for draining. Provide a 3/4" drain, with valve as directed, to nearest floor drain or slop sink, as approved.

3. In lieu of such separate gutters, a continuous protecting sheet of similar construction adequately supported and braced, properly rimmed, pitched and drained, may be provided over any such motor, and extending 2'-0" in all directions beyond the motor, over which such piping has to run.

3.11 PAINTING:

A. Comply with requirements Division 09; Section titled "Finishes."

B. All electrical motors, pump casings, and other apparatus shall be provided with three (3) coats of machinery enamel at the factory and after installation shall be carefully cleaned, rubbed down and oiled.

C. For protective coatings of other equipment such as hangers, etc., refer to that section of the specification wherein construction data is described.

D. Provide prime coat painting for the following if not provided with factory applied corrosion protection.

1. Miscellaneous steel and iron provided by Contractor responsible for the work of Division 22

2. Hangers and supports iron provided by Contractor responsible for the work of Division 22

3. Miscellaneous steel and iron provided by Contractor responsible for the work of Division 22 installed outdoors shall be provided with finished coats of exterior paint in accordance with requirements of Division 09 titled "Finishes" in addition to prime coat.

E. Damage and Touch-Up: Repair marred and damaged factory painted finishes with materials and procedures to match original factory finishes.

F. Sprinkler, standpipe, and combined sprinkler and standpipe risers, riser offsets, and cross-connections shall be painted red per N.Y.C. Building Code requirements. All piping required to be painted shall be painted regardless if it is to be concealed. Valve handles for sprinkler systems shall be painted green. Valve handles for control valves on combined risers shall be painted yellow. All run-outs to auxiliary hose outlets shall be painted red.

1. The Fire Protection contractor shall be responsible to coordinate the required painting of piping and valve handles with the painting contractor. The required painting shall be performed under Division 9 or as directed by Construction Managers.

2. Existing Building Alternations - When during alternations of existing fire protection piping (fire standpipe and or sprinkler piping) that was concealed but is exposed during renovation shall also be painted.

3. All pipe painting shall be completed prior to any required hydrostatic testing.

END OF SECTION 21 05 00

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SECTION 21 05 05 - GENERAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Access doors.
9. Equipment installation requirements common to equipment sections.
10. Painting.
11. Concrete bases.
12. Supports and anchorages.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Work

1. Division 02, CAST-IN PLACE CONCRETE.
2. Division 05, METAL FABRICATIONS.
3. Division 07, FIRESTOPPING.
4. Division 07, SEALANTS AND CAULKING.
5. Division 09, PAINTING.

6. This section is a part of each Division 21.

7. Division 21, Section 21 05 00, COMMON WORK RESULTS FOR FIRE PROTECTION.

8. Division 31, EARTHWORK.

9. Other Sections where applicable.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. Piping: Pipe, fittings, flanges, valves, controls, hangers, drains, insulation, and items customarily required in connection with the transfer of fluids.

G. By Other Trades: By persons or parties responsible for work at the project other than the party or parties who have been duly awarded the contract for the work of this Trade. In the event that this document is used to acquire work as part of a general construction contract the words "by other trades" shall mean by persons or parties who are not anticipated to be the sub-contractor for this trade working together with the general contractor. In this context the words "by other trades" shall not be interpreted to mean not included in the overall contract.

1.4 SUBMITTALS:

A. See Section 21 05 00, “Common Work Results for Fire Protection” for requirements.

PART 2- PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified. Substitutions will not be permitted unless approved by the Engineer.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 Section 21 13 13 "Wet Pipe Sprinkler Systems" for pipe, tube, and fitting materials and joining methods as well as material schedule on the drawings.

2.3 JOINING MATERIALS

A. Refer to individual Division 21 piping 211313 "Wet Pipe Sprinkler Systems" for joining methods and materials as well as material schedule on the drawings.

2.4 DIELECTRIC FITTINGS

A. Refer to individual Division 21 Section 21 13 13 "Wet Pipe Sprinkler Systems for dielectric fittings as well as material schedule on the drawings.

2.5 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

A. General

1. Provide sleeves for each pipe passing through walls, partitions, floors, and roofs. Penetrations in fire/smoke rated components shall be by UL listed assembly.

B. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

C. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

D. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

E. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

G. Sleeve Materials

Type Designation

1	Galvanized steel sheet.
2	Standard weight galvanized steel pipe.
3	Standard weight galvanized steel pipe 1/4" steel plate extending from outside of sleeve a minimum of 2" all around, similar to F&S Mfg. Corp. Fig. 204.
4	Cast iron pipe sleeve with center flange, similar to James B. Clow & Sons No. F-1430 and F-1435.
5	Standard weight galvanized steel pipe with flashing clamp device welded to pipe sleeve or watertight sleeves, similar to Zurn 195-10 with oakum and lead caulking as required.
6	Metal deck and wall sleeves. Similar to Adjust-to-Crete Manuf., Co.

H. Sleeve Sizes

1. Floors and required fire rated partitions – clearance required for pipe expansion and seismic clearances per NFPA 13 requirements maintain fire rating with UL listed firestopping assembly.

2. Partitions not fire rated - 1-1/2" maximum clearance between outside of pipe (or insulation on insulated pipes) and inside of sleeve.

3. For seismic projects, provide sleeve sizes as follows:

   a. Pipes small than 4": Sleeve 2" larger than pipe diameter.

   b. Pipes 4" and larger: Sleeve 4" larger than pipe diameter.

   c. Alternative: Provide flexible couplings within 1 ft. on each side of partition per NFPA 13 requirements.

I. Sleeve Lengths

Location	Sleeve Length
Floors	Equal to depth of floor construction including finish. In waterproof floor construction sleeves to extend minimum of 2" above finished floor level.
Roofs	Equal to depth of roof construction including insulation.
Walls & Partitions	Equal to depth of construction and terminated flush with finished surfaces.

J. Sleeve Caulking & Packing

Type Designation	Caulking & Packing Requirements
A	Space between pipe and sleeve packed with oakum or hemp and caulked watertight with lead.
B	Space between pipe or pipe covering and sleeve shall be caulked with an incombustible permanently plastic, waterproof non-staining smooth appearance or pack with mineral wool or other equally approved fire resistive material to within ½" of both wall faces and provide caulking compound as per above.

K. Sleeve Application

Sleeve Type thru Required Fire Rated Construction	Sleeve Type thru Non-Fire Rated Construction	Location	Sleeve Caulking & Packing Type Designation	Sleeve Caulking & Packing Type Thru Fire Rated Construction
5	5	Membrane waterproof floor, roof & wall construction	B	B
5	5	Non-membrane water-proof floor, roof & wall construction where flashing is required	A or B	B
2	1, 2	Interior walls, partitions & floors	B	B
3 or 4	3 or 4	Exterior walls	A	A
2	6	Cellular metal deck floors	B	B
1	1	Precast concrete floor with poured concrete topping. Note: Sleeves to have flat flanges and/or guides which rest on top of precast slab	B	B

2.7 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

C. Split-Plate, Stamped-Steel Type: With concealed or exposed-rivet hinge, set screw or spring clips, and chrome-plated finish.

2.8 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

2.9 FIRESTOPPING

A. In addition to fire protection means specified elsewhere in this specification, this trade shall comply with the following:

1. All pipe penetrations requiring Fire Stopping shall be UL listed thru-wall fire stop assemblies.

2. Contractor shall provide assembly for each type of pipe material thru fire-rated wall thickness.

3. Fire stopping assemblies shall be installed as approved by local authority having jurisdiction.

4. Fire stop assemblies shall be Rectorseal, 3M, Hilti, Tremco, or approved equal.

2.10 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

A. See Division 21, Section 21 05 29 “Hangers and Supports”.

2.11 TOOLS AND LUBRICANTS:

A. Furnish special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.

B. Lubricants: A minimum of one quart of oil, and one pound of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

2.12 ACCESS DOORS IN FINISHED CONSTRUCTION

A. Access Doors

1. Access doors as required for operation and maintenance of concealed equipment, valves, controls, etc. will be provided by another trade.

2. This Trade is responsible for access door location, size and its accessibility to the valves or equipment being served.

3. Coordinate and prepare a location, size, and function schedule of access doors required and deliver to a representative of the installing trade.

4. Access doors shall be of ample size, minimum of 16" x 16".

2.13 FOUNDATIONS

A. General

1. All equipment, piping, etc., mounted on/or suspended from approved foundations and supports, as shown on the drawings and as specified in Section 21 05 29, "Hangers and Supports".

2.14 PROTECTION OF PUBLIC WATER MAIN

A. Provide backflow prevention device on all incoming fire services as approved by the authority having jurisdiction. The backflow prevention device shall be a reduced pressure backflow device (RPZ) or detector double check valve (DCV) assembly. Refer to plans and schedules for location and model no. of all devices.

B. Provide on all incoming fire services an approved by authority having jurisdiction detector-double check valve assembly with approved displacement bypass meter with remote encoding register. Also provide double check valves on meter bypass.

C. When backflow prevention device is located more than 5'-0" from meter, piping identification is to be provided. Refer to note on drawings.

D. This contractor shall be responsible for the installation, testing, and final sign-off of each device. This includes filing the approved forms with the governing agency and paying for the cost of a licensed registered architect or engineer to perform final inspection and certify that installation has been done in accordance with approved filed plans.

2.15 FIRE METERS (Detector Checks)

A. Provide on all incoming fire services an approved by authority having jurisdiction detector-double check valve assembly with approved displacement bypass meter with remote encoding register. Also provide double check valves on meter bypass.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.

3.2 PROTECTION AND CLEANING:

A. See Section 21 05 00 - "Common Work Results for Fire Protection" for requirements.

3.3 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation as required.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. One-piece, stamped-steel type with spring clips.

M. Sleeves are not required for core-drilled holes or for holes formed by removable PE sleeves.

N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to required clear space between sleeve and pipe or pipe insulation. Use the sleeve materials as specified in paragraph 2 of this section:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).

b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.

4. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing: Secure flashing between clamping flanges. Install sleeve to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

5. Seal space outside of sleeve fittings with grout.

6. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

7. For exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

O. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to paragraph 2 of this section and Division 07 Section "Through-Penetration Firestop Systems" for materials.

Q. Verify final equipment locations for roughing-in prior to installing sleeves.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.4 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems - Section 21 06 10, “Suppression Piping”.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to Division 21, Section 21 05 29 “Hangers and Supports”.

3.7 ERECTION OF WOOD METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section 05 50 00 "Metal Fabrications" for structural steel.

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

C. Refer to Division 21, Section 21 05 29 “Hangers and Supports” for additional requirements.

D. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.

3.8 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.9 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 09 Section.

B. Sprinkler, standpipe, and combined sprinkler and standpipe risers, riser offsets, and cross-connections shall be painted red as per N.Y.C. Building Code requirements. All piping required to be painted shall be painted regardless if it is to be concealed. Valve handles for sprinkler systems shall be painted green. Valve handles for control valves on combined risers shall be painted yellow. All run-outs to auxilliary hose outlets shall be painted red.

1. The Fire Protection contractor shall coordinate required painting of piping and valve handles with the painting contractor. The required painting shall be performed under Division 9 or as directed by Construction Managers.

2. Existing Building Alternations - When during alternations of existing fire protection piping (fire standpipe and or sprinkler piping) that was concealed but is exposed during renovation, shall also be painted.

3. All pipe painting shall be completed prior to any required hydrostatic testing.

C. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

D. All electrical motors, pump casings, and other apparatus shall be provided with factory applied protective coating and after installation shall be carefully cleaned, rubbed down and oiled.

E. For protective coatings of other equipment such as hangers, etc., refer to that section of the specification wherein construction data is described.

F. Provide prime coat painting for the following:-

1. Miscellaneous steel and iron provided by this trade.

2. Hangers and supports.

3.10 DRIP PANS

A. Examine the drawings and in cooperation with the Electrical Trade confirm the final location of all electrical equipment to be installed in the vicinity of piping. Plan and arrange all overhead piping no closer than two feet from a vertical line to electric motors and controllers, switchboards, panelboards, or similar equipment. Piping is not permitted in Electric Equipment, Transformer, Switch Gear, Telephone Rooms. Except as required by the authority having jurisdiction to provide fire suppression.

B. Where the installation of piping does not comply with the requirements of foregoing paragraph, the piping shall be relocated.

C. Furnish gutters as follows:

1. Provide and erect a gutter of 16 ounce cold rolled copper or 18 gauge galvanized steel, under every pipe which is within 2'-0" from a vertical line to any motor, electrical controllers, switchboards, panelboards, or the like.

2. Each gutter shall be reinforced, rimmed, soldered and made watertight, properly suspended and carefully pitched to a convenient point for draining. Provide a 3/4" drain, with valve as directed, to nearest floor drain or slop sink, as approved.

3. In lieu of such separate gutters, a continuous protecting sheet of similar construction adequately supported and braced, properly rimmed, pitched and drained, may be provided over any such motor, and extending 2'-0" in all directions beyond the motor, over which such piping has to run.

END OF SECTION 21 05 05

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SECTION 21 05 17 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.

2. Stack-sleeve fittings.

3. Sleeve-seal systems.

4. Sleeve-seal fittings.

5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Advance Products & Systems, Inc.

2. CALPICO, Inc.

3. Metraflex Company (The).

4. Pipeline Seal and Insulator, Inc.

5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

2. Pressure Plates: Carbon steel or Stainless steel.

3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, or Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Presealed Systems.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm), or 2-inch (50-mm) for pipes 4" larger annular clear space between piping and concrete slabs and walls

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.

2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation in non-fire-rated partitions.

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 92 00 "Joint Sealants."

4. Install sleeve in fire rated construction to provide clearances as required per NFPA 13 for seismic projects.

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.

2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 62 00 "Sheet Metal Flashing and Trim."

3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.

4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves,, Galvanized-steel wall sleeves, Galvanized-steel-pipe sleeves or Sleeve-seal fittings.

b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves, Galvanized-steel wall sleeves, or Galvanized-steel-pipe sleeves.

2. Exterior Concrete Walls below Grade:

    a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system Galvanized-steel wall sleeves with sleeve-seal system Galvanized-steel-pipe sleeves with sleeve-seal system Sleeve-seal fittings

        1) Select sleeve size to allow for 1-inch (25-mm) or 4-inch (100-mm) for seismic project, annular clear space between piping and sleeve for installing sleeve-seal system.

    b. Piping NPS 6 (DN 150) <Insert pipe size> and Larger: Cast-iron wall sleeves with sleeve-seal system Galvanized-steel wall sleeves with sleeve-seal system Galvanized-steel-pipe sleeves with sleeve-seal system

        1) Select sleeve size to allow for 1-inch (25-mm) or 4-inch (100-mm) for seismic project,annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

    a. Piping Smaller Than NPS 4 (DN 100): Cast-iron wall sleeves with sleeve-seal system Galvanized-steel wall sleeves with sleeve-seal system Galvanized-steel-pipe sleeves with sleeve-seal system or Sleeve-seal fittings.

        1) Select sleeve size to allow for 1-inch (25-mm) or 4-inch (100-mm) for seismic project,annular clear space between piping and sleeve for installing sleeve-seal system.

    b. Piping NPS 4 (DN 100) and Larger: Cast-iron wall sleeves with sleeve-seal system Galvanized-steel wall sleeves with sleeve-seal system Galvanized-steel-pipe sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves .

        1) Select sleeve size to allow for 2-inch (50-mm) or 4-inch (100-mm) for seismic project, annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

    a. Piping Smaller Than NPS 6 (DN 150) Galvanized-steel-pipe sleeves Stack-sleeve fittings or Sleeve-seal fittings.

    b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves Stack-sleeve fittings.

5. Interior Partitions:

   a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.

   b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 21 05 17

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SECTION 21 05 19 - METERS AND GAUGES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes meters and gauges for fire protection systems and water meters installed outside the building.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:
1. Division 21, Section 21 05 00, “Common Work Results for Fire Protection”.
2. This section is a part of each Division 21.

C. Utility-Furnished Products: Water meters for fire protection will be furnished to site, ready for installation.

1.3 SUBMITTALS

A. Product Data: Include scale range, ratings, and calibrated performance curves for each meter, gauge, fitting, specialty, and accessory specified.

B. Shop Drawings: Include schedule indicating manufacturer's number, scale range, fittings, and location for each meter and gauge.

C. Product Certificates: Signed by manufacturers of meters and gauges certifying accuracies under specified operating conditions and compliance with specified requirements.

D. Shop Drawings: For brackets for duct-mounting thermometers.

E. Maintenance Data: For meters and gauges to include in maintenance manuals specified in Division 01. Include data for the following:

1. Flow-measuring systems.
2. Flowmeters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Pressure Gauges:

a. AMETEK, Inc.; U.S. Gauge Div.
b. Dresser Industries, Inc.; Instrument Div.; Ashcroft Commercial Sales Operation.
c. Dresser Industries, Inc.; Instrument Div.; Weksler Instruments Operating Unit.

2. Test Plugs:

a. Sisco Manufacturing Co.
b. Trerice: H. O. Trerice Co.
c. Watts Industries, Inc.; Water Products Div.

3. Wafer-Orifice-Type Flow Elements:

a. ABB, Inc.; ABB Instrumentation.
b. Armstrong Pumps, Inc.
c. Badger Meter, Inc.; Industrial Div. (Tulsa, OK).
d. ITT Fluid Technology Corp.; ITT Bell & Gossett Div.

4. Venturi-Type Flow Elements:

a. Armstrong Pumps, Inc.
b. Badger Meter, Inc.; Industrial Div. (Tulsa, OK).
c. Flow Design, Inc.
d. Hyspan Precision Products, Inc.
e. Victaulic Co. of America.

5. Pitot-Tube-Type Flow Elements:

a. Dieterich Standard Co.

6. Turbine Flowmeters:

a. Badger Meter, Inc.; Industrial Div. (Tulsa, OK).
b. George Fischer Signet, Inc.
c. Hersey Measurement Co.
d. Hoffer Flow Controls, Inc.

7. Vortex-Shedding Flowmeters:

a. Bailey-Fischer & Porter Co.
b. Schlumberger Industries, Inc.; Measurement Div.

8. Flow Indicators:

a. Dwyer Instruments, Inc.
b. Emerson Electric Co.; Brooks Instrument Div.
c. Ernst Gauge Co.

9. Water Meters:

    a. ABB Water Meters, Inc.
    b. Badger Meter, Inc.; Industrial Div. (Milwaukee, WI).
    c. Grinnell Corp.; Mueller Co.; Hersey Products Div.
    d. Neptune Water Meter.
    e. Schlumberger Industries, Inc.; Water Div.

2.2 PRESSURE GAUGES

A. Description: ASME B40.1, phosphor-bronze bourdon-tube type with bottom connection; dry type, unless liquid-filled-case type is indicated.

B. Case: Drawn steel, brass, or aluminum with 4-1/2 units (115 mm) diameter, glass lens.

C. Connector: Brass, NPS 1/4 (DN 8).

D. Scale: White-coated aluminum with permanently etched markings.

E. Accuracy: Shall be plus or minus 2 percent of middle 50 percent of scale.

F. Range: Comply with the following:

1. Vacuum: 30 inches Hg of vacuum to at least 15 psig of pressure (100 kpa) of vacuum to (103 kPa) of pressure.
2. Fluids under Pressure: Two times the operating pressure.

2.3 PRESSURE-GAUGE FITTINGS

A. Valves: NPS 1/4 (DN 8) brass or stainless-steel needle type.

B. Syphons: NPS 1/4 (DN 8) coil of brass tubing with threaded ends.

C. Snubbers: ASME B40.5, NPS 1/4 (DN 8) brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.4 TEST PLUGS

A. Description: Nickel-plated, brass-body test plug in NPS 1/2 (DN 15) fitting.

B. Body: Length as required to extend beyond insulation.

C. Pressure Rating: 500 psig (3450 kPa) minimum.

D. Core Insert: Self-sealing valve, suitable for inserting 1/8 inch (3 mm) OD probe from dial-type thermometer or pressure gauge.

E. Core Material for Water: 20 to 200 deg F (Minus 7 to plus 93 deg C), chlorosulfonated polyethylene synthetic rubber.

F. Test-Plug Cap: Gasketed and threaded cap, with retention chain or strap.

G. Test Kit: Pressure gauge and adapter with probe, two bimetal dial thermometers, and carrying case.

1. Pressure Gauge and Thermometer Ranges: Approximately two times the system's operating conditions.

2.5 FLOW-MEASURING SYSTEMS

A. System includes calibrated flow element, separate meter, hoses or tubing, valves, fittings, and conversion chart compatible with flow element, meter, and system fluid.

1. Flow range of flow-measuring element and meter covers operating range of equipment or system where used.

2. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons (liters).

B. Permanent Meters: Suitable for wall or bracket mounting. Include 6 inch (150 mm) diameter, or equivalent, dial with fittings and copper tubing for connecting to flow element.

1. Scale: gallons (liters).
2. Accuracy: Plus or minus 1 percent of center 60 percent of range.

C. Portable Meters: Differential-pressure gauge. Include two 12 foot (3.7 m) hoses in carrying case with handle.

1. Scale: Inches (Millimeters) of water, unless otherwise indicated.
2. Accuracy: Plus or minus 2 percent between 20 and 80 percent of range.

D. Include complete operating instructions with each meter.

E. Wafer-Orifice Flow Elements: Differential-pressure-design, orifice-insert flow element made for installation between pipe flanges.

1. Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.
2. Pressure Rating: 30 psig (2070 kPa) or as required for system operating pressure.
3. Temperature Rating: 250 deg F (121 deg C).

F. Venturi Flow Elements: Differential-pressure-design, flow-element fitting made for installation in piping.

1. Construction: Bronze, brass, or factory-primed steel; with brass fittings and attached tag with flow conversion data. Include ends threaded for NPS 2 (DN 50) and smaller elements and flanged or welded for NPS 2½ (DN 65) and larger elements.
2. Pressure Rating: 250 psig (1725 kPa) or as required for system operating pressure.

3. Temperature Rating: 250 deg F (121 deg C).

G. Pitot-Tube Flow Elements: Differential-pressure design with probe made for insertion into piping.

1. Construction: Stainless-steel probe of length to span inside of pipe, with brass fittings and attached tag with flow conversion data.
2. Pressure Rating: 150 psig (1035 kPa) or as required for system operating pressure.
3. Temperature Rating: 250 deg F (121 deg C).

2.6 TURBINE FLOWMETERS

A. Description: Insertion type; measures flow directly in gallons per minute (liters per second).

1. Construction: Bronze or stainless-steel body and plastic turbine or impeller, with integral direct-reading scale.
2. Pressure Rating: 150 psig (1035 kPa) minimum or as required for system operating pressure.
3. Temperature Rating: 180 deg F (82 deg C) minimum.
4. Display: Visual instantaneous rate of flow.
5. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons (liters.
6. Accuracy: Plus or minus 2-1/2 percent.

2.7 VORTEX-SHEDDING FLOWMETERS

A. In-Line Vortex-Shedding Flowmeter: Made for installation between pipe flanges; measures flow directly in gallons per minute (liters per second).

1. Construction: Stainless-steel body, with integral transmitter and direct-reading scale.
2. Pressure Rating: 1000 psig (6900 kPa) minimum.
3. Temperature Rating: 500 deg F (260 deg C) minimum.
4. Display: Visual instantaneous rate of flow.
5. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons (liters).
6. Integral Transformer: For low-voltage power operation.
7. Accuracy: Plus or minus 7/10 percent for liquids and 1-1/4 percent for gases.

B. Insertion Vortex-Shedding Flowmeter: Made for installation in pipe; measures flow directly in gallons per minute (liters per second).

1. Construction: Stainless-steel probe, with integral transmitter and direct-reading scale.
2. Pressure Rating: 1000 psig (6900 kPa) minimum.
3. Temperature Rating: 500 deg F (260 deg C) minimum.
4. Display: Visual instantaneous rate of flow.
5. Display: Visual instantaneous rate of flow, with register to indicate total volume in gallons (liters).
6. Integral Transformer: For low-voltage power connection.
7. Accuracy: Plus or minus 1 percent for liquids and 1-1/2 percent for gases.

2.8 FLOW INDICATORS

A. Description: Instrument for visual verification of flow; made for installation in piping systems.

1. Construction: Bronze or stainless-steel body, with sight glass and plastic pelton-wheel indicator.
2. Pressure Rating: 175 psig (860 kPa) or as required for system operating pressure.
3. Temperature Rating: 200 deg F (93 deg C).

2.9 WATER METERS

A. Description: AWWA C703, UL-listed, FM-approved, main-line, proportional, detector type; 150 psig (1035 kPa) working pressure; with meter on bypass. Registers flow in gallons (liters) or cubic feet (cubic meters) as required by utility.

1. Bypass Meter: AWWA C702, compound type, bronze case; size not less than one-half nominal size of main-line meter.

B. Description: AWWA C703, UL-listed, FM-approved, main-line-turbine, detector type; 175 psig (1200 kPa) working pressure; with strainer and with meter on bypass. Registers flow in gallons (liters) or cubic feet (cubic meters) as required by utility.

1. Bypass Meter: AWWA C701, turbine type, bronze case; not less than NPS 1 (DN 25).

C. Remote Registration System: Utility's standard; direct-reading type complying with AWWA C706; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly.

D. Remote Registration System: Utility's standard; encoder-type complying with AWWA C707; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly.

1. Data-Acquisition Units: Comply with utility's requirements for type and quantity.
2. Visible Display Units: Comply with utility's requirements for type and quantity.

PART 3 - EXECUTION

3.1 GAUGES

A. Provide pressure gauges in accordance with the following schedule and as shown on the plans.

B. Gauges shall have a 4-1/2" diameter dial, white coated with black figures and graduations, cast iron case with flat friction fit rings. Gauges shall be Ashcroft No. 1010 or other approved. Shutoff cock Ashcroft No. 1092, or other approved, shall be provided between gauge and piping to permit gauge removal while system is under pressure.

Gauge Location	Pressure Range
At each water service point of entry in building.	0 - 150 p.s.i.
Alarm check valve	0 - 150 p.s.i.
At each sprinkler tap from riser	0 - 150 p.s.i.

3.2 PROTECTION OF PUBLIC WATER MAIN (BACKFLOW PREVENTER)

A. Provide, on all incoming fire services, approved detector-double check valve assemblies with approved displacement bypass meter with remote encoding register. Also provide double check valves on meter bypass.

B. This contractor shall be responsible for the installation, testing, and final sign-off of each device.

3.3 PRESSURE-GAUGE INSTALLATION

A. Install pressure gauges in piping tees with pressure-gauge valve located on pipe at most readable position.

B. Install dry-type pressure gauges in the following locations:

1. Discharge of each pressure-reducing valve.
2. Building fire-service entrance.
3. Each sprinkler zone control valve.

C. Install liquid-filled-type pressure gauges at suction and discharge of each pump.

D. Install pressure-gauge needle valve and snubber in piping to pressure gauges.

3.4 FLOWMETER INSTALLATION

A. Install flowmeters and components according to manufacturer's written instructions.

3.5 FIRE WATER METER INSTALLATION

A. Install fire water meters, piping, and specialties according to AWWA M6 and utility's requirements.

3.6 ROUGHING-IN FOR FIRE WATER METERS

A. Install roughing-in piping and specialties for water meter installation according to utility's instructions and requirements.

3.7 CONNECTIONS

A. Piping installation requirements are specified in other Division 21 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

1. Install meters and gauges adjacent to machines and equipment to allow service and maintenance.
2. Connect flow-measuring-system elements to meters.
3. Connect flowmeter transmitters to meters.
4. Connect thermal-energy-flowmeter transmitters to meters.

B. Make electrical connections to power supply and electrically operated meters and devices.

C. Ground electrically operated meters.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Install electrical connections for power and devices.

E. Electrical power, wiring, and connections are specified in Division 26 Sections.

3.8 ADJUSTING AND CLEANING

A. Calibrate meters according to manufacturer's written instructions, after installation.

B. Adjust faces of meters and gauges to proper angle for best visibility.

C. Clean windows of meters and gauges and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 21 05 19

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SECTION 21 05 29 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes hangers and supports for fire protection system piping and equipment; including the following:

1. Elastomeric isolation pads and mounts.
2. Restrained elastomeric isolation mounts.
3. Freestanding and restrained spring isolators.
4. Housed spring mounts.
5. Elastomeric hangers.
6. Spring hangers.
7. Spring hangers with vertical-limit stops.
8. Thrust limits.
9. Pipe riser resilient supports.
10. Resilient pipe guides.
11. Freestanding and restrained air spring isolators.
12. Restrained vibration isolation roof-curb rails.
13. Seismic snubbers.
14. Restraining cables.
15. Steel or Inertia, vibration isolation equipment bases.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 05, "Metal Fabrications" for materials for attaching hangers and supports to building structure.
2. Division 21 Section 21 05 00 “Common Work Results for Fire Protection”.

3. This Section is a part of each Division 21.

4. Division 21 Section 21 13 13 “Wet Pipe Sprinkler Systems” for fire-suppression pipe hangers.

1.3 DEFINITIONS

A. NFPA: National Fire Protection Association

B. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.

C. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

D. A: Effective peak velocity related acceleration coefficient.

E. OSHPD: Office of Statewide Health Planning & Development for the State of California. OSHPD assigns a unique anchorage preapproval "R" number to each seismic restraint it tests. The number describes a specific device applied as tested.

F.

UL	Underwriters Laboratories, Inc.
NEMA	National Electrical Manufacturers Assn.
FM	Factory Mutual
USAS	United States of America Standards Institute
ANSI	American National Standards Institute
AWWA	American Water Works Association
ASCE	American Society of Civil Engineers
F.S.	Federal Specifications, U.S. Government
FEMA	Federal Emergency Management Agency
DHS	Department of Homeland Security
GSA	United States General Services Administration
I.S.O.	Insurance Services Organization

DEAD LOADS The weight of materials of construction incorporated into the building, including but not limited to walls, floors, roofs, ceilings, stairways, built-in partitions, finishes, cladding and other similarly incorporated architectural and structural items, and the weight of fixed service equipment, such as cranes, plumbing stacks and risers, electrical feeders, heating, ventilating and air-conditioning systems and fire suppression systems.

DESIGN STRENGTH The product of the nominal strength and a resistance factor (or strength reduction factor).

DURATION OF LOAD The period of continuous application of a given load, or the aggregate of periods of intermittent applications of the same load.

ESSENTIAL FACILITIES Buildings and other structures that are intended to remain operational in the event of extreme environmental loading from flood, wind, snow or earth quakes.
FACTORED LOAD The product of a nominal load and a load factor.

IMPACT LOAD The load resulting from moving machinery, elevators, craneways, vehicles and other similar forces and kinetic loads, pressure and possible surcharge from fixed or moving loads.

LIMIT STATE A condition beyond which a structure, member or system component becomes unfit for service and is judged to be no longer useful for its intended function (serviceability limit state) or to be unsafe (strength limit state).

LIVE LOADS Those loads produced by the use and occupancy of the building or other structure and do not include construction or environmental loads such as wind load, snow load, rain load, earth quake load, flood load or dead load.

LOAD AND RESISTANCE FACTOR DESIGN (LRFD) A method of proportioning structural members and their connections using load and resistance factors such that no applicable limit state is reached when the structure is subjected to appropriate load combinations. The term "LRFD" is used in the design of steel and wood structures.

LOAD FACTOR A factor that accounts for deviations of the actual load from the nominal load, for uncertain ties in the analysis that trans forms the load into a load effect, and for the probability that more than one extreme load will occur simultaneously.

LOADS Forces or other actions that result from the weight of building materials, occupants and their possessions, environmental effects, differential movement and restrained dimensional changes. Permanent loads are those loads in which variations over time are rare or of small magnitude, such as dead loads. All other loads are variable loads (see also "Nominal loads").

LOADS EFFECTS Forces and deformations produced in fire protection and building systems by the applied per dynamic loads.

NOMINAL LOADS The magnitudes of the loads specified in this specification (dead, live, soil, wind, snow, rain, flood and earthquake).

OCCUPANCY CATEGORY A category used to determine structural requirements based on occupancy.

1.4 GENERAL DESIGN REQUIREMENTS

A. It shall be understood that the requirements of this section are complementary to requirements delineated elsewhere for the support and fastening of equipment, piping, etc. Nothing on the drawings or specifications shall be interpreted as a reason to waive the requirements of this section.

B. Floor mounted equipment shall be provided with approved mounting devices as required to prevent overturning or sliding.

C. Ceiling mounted equipment shall be provided with approved mounting devices as required to maintain the equipment in a captive attitude under nominal loads.

D. The structural attachment design and construction requirements for equipment and piping incorporated as part of Life Safety Systems shall be such that these systems will remain in place and be functional and that the design shall consider lateral drifts between stories as specified by code.

E. All life safety systems whether isolated or not shall be securely fastened to structure to allow for the required acceleration or nominal load. Bolt points and diameter of inserts shall be submitted and verified as part of the contractor's submission for each piece of equipment and certified by a licensed structural engineer.

F. Restrain all piping in accordance with NFPA requirements, comply with the local Building Code.

G. All restraints shall be capable of safely accepting external forces required for life safety equipment without failure and shall maintain equipment, piping, etc. in a captive position. Restraints shall not short circuit isolation systems or transmit objectionable vibration or noise, and shall be provided on all equipment as scheduled on drawings. Calculations by registered structural engineer shall be submitted to verify snubber capabilities for each piece of equipment.

H. For all piping, regardless of size or length of support, all connections to the building structure must be positively made. Connections which depend all or in part on friction for their supporting action are not acceptable.

I. Do not use branch lines to brace main lines.

J. A rigid piping system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.

K. Provide pipe sleeves through walls or floors large enough to allow for anticipated differential movements.

L. At vertical pipe risers, wherever possible, support the weight of the riser at a point or points above the center of gravity of the riser. Provide lateral guides at the top and bottom of the riser and at intermediate points not to exceed 30' on center.

M. Fire sprinkler piping system shall be provided, meeting the requirements of NFPA 13. Note that the suggested layouts permit bracing of headers and mains without bracing of branch lines.

1.5 PERFORMANCE REQUIREMENTS

A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and dynamic forces (water thrust and nominal loads), including weight allowances as required by NFPA 13, and local building and fire codes.

B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and dynamic forces (water thrust and nominal loads), including weight allowances as required by NFPA 13 and local building and fire codes.

C. Design and obtain approval from authorities having jurisdiction for thrust restraint, hangers, and supports for piping and equipment.

1.6 SUBMITTALS

A. Product Data: For each type of structural attachment, including hangers, support, isolators, restraints and bases as indicated or required.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:

1. Design Calculations: Calculate requirements for selecting structural attachments, including supports, hangers, isolators restraints and for designing bases.

2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

3. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/2-inch (13-mm) deflection in x, y, and z planes.

C. Welding certificates, including Welder experience as required by local code.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03 Cast-In-Place Concrete.

B. Coordinate installation of roof-top equipment and roof penetrations. These items are specified in Division 07, Roof Accessories.

PART 2 - PRODUCTS

2.1 HANGERS AND SUPPORTS:

A. Piping shall be supported from the building structure in accordance with the standard listed above.

B. Support hangers from approved concrete inserts where concrete slabs are available.

C. All hangers, rods, inserts, clamps, stanchions, brackets, shall be dipped in zinc chromite primer before installation or shall be galvanized.

D. Where "C" clamp hanger attachments are utilized, retainer clips shall be provided on each clamp.

E. Piping 3" and smaller shall utilize adjustable swivel loop hangers.

F. Piping 4" and larger shall utilize clevis type hangers only.

G. All hanger rods shall be double nutted.

H. Chain straps, perforated bars, wire hangers are not permitted.

2.2 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements of Factory Mutual, Underwriters Laboratory; provide products by one of the following:

1. Pipe Hangers:

   a. Toleco
   b. B-Line Systems, Inc.
   c. Grinnell Corp.

2. Channel Support Systems:

   a. B-Line Systems, Inc.
   b. Grinnell Corp.; Power-Strut Unit.
   c. Unistrut Corp.

3. Thermal-Hanger Shield Inserts:

   a. Michigan Hanger Co., Inc.

4. Powder-Actuated Fastener Systems:

   a. Hilti, Inc.

2.3 MANUFACTURED UNITS

A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.

1. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.

2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.

1. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

C. Thermal-Hanger Shield Inserts: 100 psi (690 kPa) minimum compressive-strength insulation, encased in sheet metal shield.

1. Material for Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.

2. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.

3. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.

4. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.4 VIBRATION ISOLATORS

A. Available Manufacturers:

1. B-Line Systems, Inc.
2. Mason Industries, Inc.
3. Vibration Eliminator Co., Inc.

B. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

C. Elastomeric Mounts: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

D. Restrained Elastomeric Mounts: All-directional elastomeric mountings with seismic restraint.

1. Materials: Cast-ductile-iron housing containing two separate and opposing, molded, bridge-bearing neoprene elements that prevent central threaded sleeve and attachment bolt from contacting the casting during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

E. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

2. Minimum Additional Travel: 50 percent of the required deflection at rated load.

3. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4 inch (6 mm) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig (690 kPa).

6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4 inch (6 mm) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.

1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.

2. Base: Factory drilled for bolting to structure.

3. Snubbers: Vertically adjustable to allow a maximum of 1/4 inch (6 mm) travel before contacting a resilient collar.

H. Elastomeric Hangers: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

I. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

J. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

K. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression and with a load stop. Include rod and angle-iron brackets for attaching to equipment.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7. Coil Spring: Factory set and field adjustable for a maximum of 1/4 inch (6 mm) movement at start and stop.

L. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2 inch (13 mm) thick, 60-durometer neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig (3.45 MPa) and for equal resistance in all directions.

M. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes separated by a minimum of 1/2 inch (13 mm) thick, 60-durometer neoprene. Factory set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.5 FACTORY FINISHES

A. Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

C. Powder coating on springs and housings.

D. All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.

E. Baked enamel for metal components on isolators for interior use.

F. Color-code or otherwise mark vibration isolation and movement control devices to indicate capacity range.

2.6 MISCELLANEOUS MATERIALS

A. Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

C. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.

D. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.

E. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.

F. Properties: Nonstaining, noncorrosive, and nongaseous.

G. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.

H. All hanger rods shall be dipped in zinc chromite primer before installation or shall be galvanized, all hanger rods shall be double nutted.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive attachments, including vibration isolation and movement control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.

B. Install snubbers on isolated equipment. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

C. Install restraining cables at each trapeze and individual pipe hanger. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.

D. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers. At trapeze anchor locations, shackle piping to trapeze. Requirements apply equally to hanging equipment. Do not weld angles to rods.

E. Install resilient bolt isolation washers on equipment anchor bolts.

3.3 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing:

B. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

3.4 ADJUSTING

A. Adjust isolators after piping systems have been filled and equipment is at operating weight.

B. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4 inch (6 mm) movement during start and stop.

C. Adjust spring leveling mechanism.

D. Adjust active height of spring isolators.

E. Torque anchor bolts according to equipment manufacturer's written recommendations to resist design forces.

3.5 CLEANING

A. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 01 Section 01 73 00 “Execution Requirements”.

3.7 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger requirements are specified in Sections specifying equipment and systems.

B. Comply with Factory Mutual, Underwriters Laboratory, NFPA and MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.

C. Chain straps, perforated bars, wire hangers are not permitted except for lateral (seismic) bracing.

D. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 4" to NPS 30 (DN100 to DN750).

2. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN15 to DN100), to allow off-center closure for hanger installation before pipe erection.

3. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 3 (DN20 to DN80).

4. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8 (DN10 to DN200).

5. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2 1/2 to NPS 36 (DN65 to DN900), if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

6. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30 (DN25 to DN750), from two rods if longitudinal movement caused by expansion and contraction might occur.

7. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2 1/2 to NPS 20 (DN65 to DN500), from single rod if horizontal movement caused by expansion and contraction might occur.

8. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN50 to DN750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

E. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500).

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500), if longer ends are required for riser clamps.

F. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

G. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19) (Provide retainer clip with each C-Clamps): For use under roof installations with bar-joist construction to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23) (Provide retainer clip with each C-Clamps): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb. (340 kg).
    b. Medium (MSS Type 32): 1500 lb. (675 kg).
    c. Heavy (MSS Type 33): 3000 lb. (1350 kg).

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.

H. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100 psi (690 kPa) minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

I. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1 1/4 inches (32 mm).

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard thrust sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

a. Horizontal (MSS Type 54): Mounted horizontally.
b. Vertical (MSS Type 55): Mounted vertically.
c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

3.8 HANGER AND SUPPORT INSTALLATION

A. Pipe Hanger and Support Installation: Comply with local code, Factory Mutual, Underwriters Laboratory, NFPA and MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.

1. Field assemble and install according to manufacturer's written instructions.

C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

D. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in local code, Factory Mutual, Underwriters Laboratory, NFPA, and MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping (thrust load). Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

E. Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

F. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

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

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by local code, Factory Mutual, Underwriters Laboratory, NFPA, and ASME B31.9, "Building Services Piping," is not exceeded.

K. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

   a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.

   b. Piping Operating Below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

   c. Do not exceed pipe stress limits according to ASME B31.9.

2. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40 protective shields on piping with vapor barrier. Shields shall span arc of 180 degrees.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3 1/2 (DN8 to DN90): 12 inches (305 mm) long and 0.048 inch (1.22 mm).

   b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.

   c. NPS 5 and NPS 6 (DN125 and DN150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.

   d. NPS 8 to NPS 14 (DN200 to DN350) : 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.

   e. NPS 16 to NPS 24 (DN400 to DN600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood inserts.

6. Insert Material: Length at least as long as protective shield.

7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.9 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.10 FOUNDATIONS, PADS AND VIBRATION ISOLATION:

A. General

1. All equipment, piping, etc., mounted on/or suspended from approved foundations and supports, as specified, as shown on the drawings.

2. All concrete foundations and supports (and required reinforcing and forms) will be provided by another trade. This trade shall furnish shop drawings showing adequate concrete reinforcing steel details and templates for all concrete foundations and supports, and all required hanger bolts and other appurtenances necessary for the proper installation of his equipment. Although another trade will complete all concrete work, all such work shall be shown in detail on the shop drawings, prepared by this trade, which drawings shall be submitted showing the complete details of all foundations including necessary concrete and steel work, etc.

3.11 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.

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

C. Field Welding: Comply with Factory Mutual, Underwriters Laboratory, and AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.12 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.13 PAINTING

A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

B. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

C. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 Section "Painting."

D. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.14 PANS AND DRAINS OVER ELECTRICAL EQUIPMENT:

A. This contractor shall examine the drawings and in cooperation with the Electrical Trade confirm the final location of all electrical equipment to be installed in the vicinity of piping. Plan and arrange all overhead piping no closer than 6'-0" feet from a vertical line above electrical equipment, including but not limited to, elevator machine room equipment, main switchgear equipment, motor control centers, starter, electric motors, switchboards, panelboards, or similar equipment. Piping is not permitted in Electric Equipment, Transformer, Switch Gear, Elevator Equipment, Telephone Gear and Fire Pump Rooms.

B. Where the installation of piping does not comply with the requirements of the foregoing paragraph, where feasible the piping shall be relocated.

C. Furnish gutters as follows:

1. Provide and erect a gutter of 16 ounce cold rolled copper or 18 gauge galvanized steel, under every pipe which is within 6'-0" from a vertical line to any motor, electrical controllers, switchboards, panel boards, or the like.

2. Each gutter shall be reinforced, rimmed, soldered and made watertight, properly suspended and carefully pitched to a convenient point for draining. Provide a 3/4" drain, with valve as directed, to nearest floor drain or slop sink, as approved.

3. In lieu of such separate gutters, a continuous protecting drain pan of similar construction adequately supported and braced, properly rimmed, pitched and drained to a floor drain or suitable waste, may be provided over any such electrical equipment, and extending 3'-0" in all directions beyond the electrical equipment, over which such piping has to run.

END OF SECTION 21 05 29

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.3 SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.

D. Valve Schedules: Valve numbering scheme.

E. Valve Schedules: For each piping system, furnish to Owner's Representative three (3) complete framed plastic laminated valve tag schedules. Schedule shall indicate tag number, valve location by floor and nearest column number, valve size and service controlled. Furnish extra copies of the valve and equipment schedules (in addition to mounted copies) to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Maintenance Data: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Stainless steel or anodized aluminum, with data engraved or stamped, for permanent attachment on equipment.

1. Data:

a. Manufacturer, product name, model number, and serial number.

b. Capacity, operating and power characteristics, and essential data.

c. Labels of tested compliances.

2. Location: Nameplate shall be located on the equipment in a location which is accessible and visible when the equipment is installed.

3. Fasteners: As required to mount on equipment in a permanent (tamper resistant) manner.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: Match schedules as closely as possible.

2. Data:

a. Name and plan number.

b. Equipment service.

c. Design capacity.

d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

3. Size: 2-1/2 by 4 inches (64 by 100 mm) for control devices and valves; 4-1/2 by 6 inches (115 by 150 mm) for equipment.

C. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Data: Instructions for operation of equipment and for safety procedures.

2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.

3. Thickness: 1/16 inch (1.6 mm), unless otherwise indicated.

4. Thickness: 1/16 inch (1.6 mm) for units up to 20 sq. in. (130 sq. cm) or 8 inches (200 mm) in length, and 1/8 inch (3.2 mm) for larger units.

5. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

D. Access Panel and Door Markers: 1/16 inch (1.6 mm) thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8 inch (3.2 mm) center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Apply Opti-code pressure sensitive vinyl color coded pipe markers identifying pipe contents and direction of flow.

2. On exposed piping apply markers on 30 foot centers of straight runs, at valve locations, at points where piping enters and leaves a partition, wall, floor or ceiling.

3. On concealed piping installed above removable ceiling construction apply markers in manner described for exposed piping.

4. On concealed piping installed above non-removable ceiling construction, or in pipe shafts, apply markers at valve or other devices that are made accessible by means of access doors or panels.

5. Marker widths shall be 8" for pipes up to 2" diameter and 12" wide for 2-1/2" to 6" diameter piping and 24" wide for larger diameter piping. Letter heights stating service shall be preprinted on marker 3/4" high for 8" markers 1-1/4" high for 12" markers and 2-1/2" high for 24" markers.

6. For painted or insulated pipes apply markers after insulation and painting work has been completed.

7. Colors shall conform to ANSI Standard A13.1. Provide 24 additional markers of each type for future use by Owner's personnel.

8. Follow manufacturer's instructions for application procedures using non-combustible materials and contact adhesives. Loop 3/4" wide pressure-sensitive tape of same color as marker background around pipe at both ends of marker and overlap tape on itself a minimum of 2".

9. Markers and tape manufactured by Seton Name Plate Co. or other approved.

10. Colors: Comply with ASME A13.1, unless otherwise indicated.

11. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

12. Pipes with OD, Including Insulation, Less Than 6 inches (150 mm) : Full-band pipe markers extending 360 degrees around pipe at each location.

13. Pipes with OD, Including Insulation, 6 inches (150 mm) and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.

14. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

D. Self-Adhesive Pipe Markers: Plastic with pressure-sensitive, permanent-type, self-adhesive back.

E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils (0.08 mm) thick with pressure-sensitive, permanent-type, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 inches (150 mm): 3/4 inch (19 mm) minimum.

2. Width for Markers on Pipes with OD, Including Insulation, 6 inches (150 mm) or Larger: 1-1/2 inches (38 mm) minimum.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; pipe size; and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches (38 mm) high.

E. Pipe-Label Colors:

1. Background Color: Red.

2. Letter Color: White.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Aluminum.

2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.

3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping-system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: Brass, 0.032 inch (0.8 mm) thick, with predrilled holes for attachment hardware.

2. Fasteners: Brass wire-link chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches (100 by 178 mm).

2. Fasteners: Brass grommet and wire.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 LABEL INSTALLATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install or permanently fasten labels on each major item of mechanical equipment.

D. Locate equipment labels where accessible and visible.

3.3 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of fire protection equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible.

B. Install equipment markers with permanent adhesive on or near each major item of fire protection equipment. Data required for markers may be included on signs, and markers.

1. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

2. Locate markers where accessible and visible. Include markers for the following general categories of equipment:

a. Main control and operating valves, including safety devices.

b. Meters, gauges, and similar units.

3. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.

3.4 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

B. Stenciled Pipe Marker Option: Stenciled markers may be provided instead of manufactured pipe markers, at Installer's option. Install stenciled pipe markers with painted, color-coded bands complying with ASME A13.1 on each piping system.

1. Identification Paint: Use for contrasting background.

2. Stencil Paint: Use for pipe marking.

C. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.

7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

D. Provide piping identification required by local fire and building department requirements.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves and hose connections. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions as indicated in the previous articles:

1. Valve-Tag Size and Shape:

a. Fire Protection: 2 inches (50 mm), round or square.

2. Valve-Tag Color:

a. Fire Protection: Red

3. Letter Color:

a. Fire Protection: Black or White.

C. Provide valve tags as required by local fire and building department requirements.

3.6 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.8 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.9 CLEANING

A. Clean faces of fire protection identification devices and glass frames of valve schedules.

END OF SECTION 21 05 53

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SECTION 21 08 00 – FIRE PROTECTION TESTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section includes the following basic fire protection materials and methods to complement other Division 21 Sections.

B. This Section includes general requirements for electrical field testing and inspecting. Detailed requirements are specified in each Section containing components that require testing. General requirements include the following:

1. Coordination requirements for testing and inspecting

2. Reporting requirements for testing and inspecting.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

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

1. Section 21 05 00 “Common Work Results for Fire Protection”.

2. This section is a part of each Division 21.

1.3 QUALITY ASSURANCE

A. As specified in each Section containing fire protection testing requirements.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 GENERAL TESTS AND INSPECTIONS

A. Where no specific requirements are given, provide testing in accordance with the latest version of the relevant NFPA standards for systems to be tested.

B. Where tests are specified to be performed by an independent testing agency, prepare systems, equipment, and components for tests and inspections, and perform preliminary tests to ensure that systems, equipment, and components are ready for independent agency testing.

C. Test and Inspection Reports: In addition to requirements specified elsewhere, report the following:

1. Manufacturer's written testing and inspecting instructions.

2. Calibration and adjustment settings of adjustable and interchangeable devices involved in tests.

3. Tabulation of expected measurement results made before measurements.

4. Tabulation of "as-found" and "as-left" measurement and observation results.

3.2 SPECIFIC TESTS

A. Provide all designating signs for shutoff valves, control valves, alarms, and the like, as required by the authorities having jurisdiction.

B. Testing of Systems

1. Perform all required tests in the manner prescribed by and to the satisfaction of the local building department and local fire department, NFPA, Owners Insurance Underwriters, and all authorities having jurisdiction. Owners and Architects representatives shall be present to witness tests. Obtain all required certificates of approval and pay any fees or costs in conjunction therewith.
2. Provide and pay for all devices, materials, supplies, labor and power required in connection with all tests. All tests shall be made in the presence and to the satisfaction of the Architect and inspectors having jurisdiction.
3. Defects disclosed by the tests shall be repaired, or if required by the Architect, defective work shall be replaced with new work without extra charge to the Owner. Tests shall be repeated as directed, until all work is proven satisfactory.
4. This Contractor shall also be responsible for the work of other trades that may be damaged or disturbed by the tests, or the repair or replacement of his own work, and he shall, without extra charge to the Owner, restore to its original condition, work of the trades so damaged and disturbed, engaging the original Contractors to do the work of restoration.
5. Hydrostatic Tests

    a. Hydrostatically test all system piping and equipment per NFPA 13, 14 and zone requirements.

    b. Sprinkler to be tested at 200 psi for 2 hours.

3.3 TESTING OF FIRE SAFETY SYSTEMS

A. Include in the base bid price sufficient man hours to conduct tests of fire safety systems. The trades shall jointly assign personnel to test the following

1. Electric

2. HVAC Fans and Dampers

3. Automatic Controls and Signals

4. Fire Suppression System (Sprinkler, Pre-action, etc.)

5. Fire Protective Alarm System

B. This trade shall coordinate with other trades and jointly test all systems. When all systems are working properly, inform Owner in writing so that Owner's representative can witness.

C. Perform all testing and commissioning as outlined in related sections of this specification.

3.4 COMMISSIONING

A. Provide manpower as required to assist the commissioning agent, as required in Division 01 Section "GENERAL COMMISSIONING REQUIREMENTS" and Division 01 Section "HVAC COMMISSIONING REQUIREMENTS".

END OF SECTION 21 08 00

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SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Fire-department connections.
4. Sprinklers.
5. Alarm devices.
6. Manual control stations.
7. Control panels.
8. Pressure gages.

B. Work Included

1. The complete system shall include all fire department connections, roof manifolds, hose stations, fire department outlets, fire, jockey pumps & controllers, valves, wet sprinklers, dry sprinklers, piping, drain risers, pressure reducing valves, cabinets, alarms as required for a complete system. Building or area will be fully sprinklered (exception only as per local code).
2. All areas will be supplied from a combination, standpipe, or sprinkler riser system.
3. Areas exposed to freezing will have a dry pipe sprinkler system or heat trace wet piping.
4. Before any work is commenced, shop drawings shall be carefully prepared and submitted for approval. It is required that the sprinkler systems be sized hydraulically in accordance with NFPA standards. Submit hydraulic calculation for each system, floor and zone with shop drawings showing balanced system delivery, and balanced supply and demand for the appropriate hazard class as defined in NFPA 13, latest edition accepted by local authority having jurisdiction. Such drawings and calculations must be reviewed and approved by all governing authorities, Fire Department, Owners Insurance Underwriters, Factory Mutual and/or Industrial Risk Insurers before any work is commenced at the jobsite.

C. Related Sections:

1. Division 28, Fire Alarm Systems for alarm devices not specified in this Section.

1.3 DEFINITIONS

A. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig (1200 kPa).

B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.

1.4 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.5 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) working pressure.

B. High-Pressure Piping System Component: Listed for over 175 psig (1200-kPa) working pressure.

C. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, with 10 psi minimum, including losses through water-service piping, valves, and backflow preventers. Available safety margin to be confirmed based on hydraulic calculations performed for the system as installed.

2. Sprinkler Occupancy Hazard Classifications:

a. Automobile Parking Areas: Ordinary Hazard, Group 1.

b. Building Service Areas: Ordinary Hazard, Group 1.

c. Electrical Equipment Rooms: Ordinary Hazard, Group 1.

d. General Storage Areas: Ordinary Hazard, Group 1.

e. Laundries: Ordinary Hazard, Group 1.

f. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.

g. Office and Public Areas: Light Hazard.

h. Restaurant Service Areas: Ordinary Hazard, Group 1.

3. Minimum Density for Automatic-Sprinkler Piping Design:

   a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m) area.

   b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. (6.1 mm/min. over 139-sq. m) area.

   c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. (8.1 mm/min. over 139-sq. m) area.

   d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. (12.2 mm/min. over 232-sq. m) area.

   e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. (16.3 mm/min. over 232-sq. m) area.

   f. Special Occupancy Hazard: As determined by authorities having jurisdiction.

   g. For areas with ceilings with pitch greater than 2 in 12, increase design area in accordance with NFPA 13 required.

   h. For areas with ceiling heights (H) 20 ft. or higher, the area of application shall be the ceiling height (H) x 100 sq. ft., plus the sprinkler shall have a k factor of 11 or greater.

4. Maximum Protection Area per Sprinkler: Per UL listing and NFPA 13 requirements.

   a. Office Spaces: 225 sq. ft. (20.9 sq. m) (hydraulically calculated)

   b. Storage Areas: 130 sq. ft. (12.1 sq. m) or as required by NFPA13 and local code.

   c. Mechanical Equipment Rooms: 130 sq. ft. (12.1 sq. m) (hydraulically calculated).

   d. Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m) (hydraulically calculated).

   e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:

   a. Light-Hazard Occupancies: 100 gpm (6.3 L/s) for 30 minutes.

   b. Ordinary-Hazard Occupancies: 250 gpm (15.75 L/s) for 60 to 90 minutes.

   c. Extra-Hazard Occupancies: 500 gpm (31.5 L/s) for 90 to 120 minutes

D. The sprinkler heads in all areas are to be installed in the center of the tile or centered with lights, diffusers or similar elements as indicated on the architectural reflected ceiling drawings. Sprinkler heads must also be installed on a true axis line in both directions with a maximum deviation from the axis line of ½" plus or minus. At the completion of the installation, if any heads are found to exceed the above mentioned tolerance, same shall be removed and reinstalled by this Contractor at no additional cost to the Owner.

E. Provide all sprinkler heads and work in strict conformance with reviewed shop drawings. The Architect and/or Design Engineer reserves the right to reject any and all work not in accordance with the reviewed shop drawing.

F. Whether or not the system shown on the Contract Drawings meets all applicable code requirements, these specifications require the furnishing and installation of sprinkler systems complete in all details and in accordance with code requirements.

G. Perform the following in areas where painting occurs or when sprinkler piping is painted. As soon as sprinkler heads are in place and the Contractor shall cover each head with a small bag of an Underwriter's approved type, which shall be removed only after all painting is complete. After the bag is removed, all heads shall be cleaned and polished.

H. Hydraulic Calculations: Submit hydraulic calculations as part of the shop drawings. Include hydraulic calculations for each floor, zone and sprinkler system. Prepare hydraulic calculations in accordance with NFPA 13 and the design criteria indicated on the drawings with the following exceptions:

1. Minimum operating pressure of any sprinkler head shall be according to NFPA 13, manufacturer requirements and UL listing or/FM approval.

2. Pipe friction losses may be calculated by using the nearest foot for all piping over one foot in length. Horizontal lengths less than one foot may be neglected. Vertical length less than one foot shall be included for elevation purposes only.

3. Flows shall be calculated to the nearest whole gallon.

4. Velocity pressures may be neglected.

5. Refer to sprinkler design criteria on drawings for additional information.

I. Sprinkler System design shall be approved by the authorities having jurisdiction, including local building and fire departments.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittal:

1. Product Data for Credit EQ 4.1: For solvent cements and adhesive primers, including printed statement of VOC content and chemical components.

C. Shop Drawings: For all sprinkler systems. Include plans, elevations, sections, details, and attachments to other work. Comply with NFPA 13 requirements for working plans.

1. Wiring Diagrams: For power, signal, and control wiring.

D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Domestic water and all plumbing system piping.

2. Compressed air piping.

3. HVAC hydronic piping.

4. Items penetrating finished ceiling include the following:

a. Lighting fixtures.

b. Air outlets and inlets.

E. Qualification Data: For qualified Installer.

F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

G. Welding certificates.

H. Fire-hydrant flow test report.

I. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

J. Field quality-control reports.

K. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

L. Record/As-Built Drawings: Submit record/as-built drawings to the Architect and Engineer for approval. The drawings are to comply with NFPA 13 requirements for record drawings.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems. Base calculations on results of fire-hydrant flow test.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."

2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

E. Systems, installation, equipment and materials shall conform to requirements of the local Building Code, Owners Insurance Underwriters, Factory Mutual, Industrial Risk Insurers, local Fire Department, ANSI/ASME B31.9 “Building Service Piping” and all authorities having jurisdiction. Equipment and materials Underwriters listed, labeled and approved as required.

1.8 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes. All pipe shall be manufactured domestically.

B. The use of galvanized piping and fittings for wet systems is permitted only for the drain lines, the piping between the fire department connections and system check valve and where specifically indicated on the drawings.

2.2 STEEL PIPE AND FITTINGS

A. Standard Weight, Galvanized and Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end. Not permitted on cross mains and risers.

C. Galvanized and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

D. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.

E. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Malleable- or Ductile-Iron Unions: UL 860.

G. Cast-Iron Flanges: ASME 16.1, Class 125.

H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

J. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, include products from one of the following:

a. Anvil International, Inc.

b. Tyco Fire & Building Products LP.

c. Victaulic Company.

d. Reliable.

2. Pressure Rating: 175 psig (1200 kPa), or greater as required for project conditions.

3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.

4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

K. Mechanical Victaulic type joint

1. For steel pipe Victaulic type 77, 75, 72, Zero-flex and 005, 009 Firelock are the only approved coupling to be used with grooved piping. Couplings shall be galvanized when used with galvanized piping. All grooves on piping that is galvanized shall be properly cleaned and provided with zinc chromate primer. See pipe material schedule.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.

1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.

2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 COVER SYSTEM FOR SPRINKLER PIPING

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

1. DecoShield Systems, Inc.

B. Description: System of support brackets and covers made to protect sprinkler piping.

C. Brackets: Glass-reinforced nylon.

2.5 LISTED FIRE-PROTECTION VALVES

A. General Requirements:

1. Valves shall be UL listed or FM approved.

2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa), or greater as required for project conditions.

B. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

a. Anvil International, Inc.

b. Victaulic Company.

c. NIBCO.

2. Standard: UL 1091 except with ball instead of disc.

3. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.

4. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.

5. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.

C. Bronze Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

   a. Milwaukee Valve Company.

   b. NIBCO.

2. Standard: UL 1091.

3. Pressure Rating: 175 psig (1200 kPa) equal, or greater as required for projection conditions.

4. Body Material: Bronze.

5. End Connections: Threaded.

D. Iron Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

   a. Milwaukee Valve Company.

   b. NIBCO INC.

   c. Victaulic Company.

2. Standard: UL 1091.

3. Pressure Rating: 175 psig (1200 kPa), or greater as required for project conditions.

4. Body Material: Cast or ductile iron.

5. Style: Lug or wafer.

6. End Connections: Grooved.

E. Check Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

   a. Milwaukee Valve Company.

   b. NIBCO INC.

   c. Victaulic.

   d. Reliable.

2. Standard: UL 312.

3. Pressure Rating: 250 psig (1725 kPa) minimum, or greater as required for project conditions.

4. Type: Swing check.

5. Body Material: Cast iron.

6. End Connections: Flanged or grooved.

F. Bronze OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

a. Crane Co.; Crane Valve Group; Stockham Division.

b. Milwaukee Valve Company.

c. NIBCO INC.

2. Standard: UL 262.

3. Pressure Rating: 175 psig (1200 kPa), or greater as required for project conditions..

4. Body Material: Bronze.

5. End Connections: Threaded.

G. Iron OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

a. Crane Co.; Crane Valve Group; Stockham Division.

b. NIBCO INC.

c. Kennedy Valve.

2. Standard: UL 262.

3. Pressure Rating: 250 psig (1725 kPa) minimum, or greater as required for project conditions.

4. Body Material: Cast or ductile iron.

5. End Connections: Flanged or grooved.

H. Indicating-Type Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

   a. Milwaukee Valve Company.

   b. NIBCO INC.

   c. Victaulic Company.

2. Standard: UL 1091.

3. Pressure Rating: 175 psig (1200 kPa) minimum, or greater as required for project conditions.

4. Valves NPS 2 (DN 50) and Smaller:

   a. Valve Type: Ball or butterfly.

   b. Body Material: Bronze.

   c. End Connections: Threaded.

5. Valves NPS 2-1/2 (DN 65) and Larger:

   a. Valve Type: Butterfly.

   b. Body Material: Cast or ductile iron.

   c. End Connections: Flanged, grooved, or wafer.

6. Valve Operation: Integral electrical, prewired, supervisory switch with visual indicating device.

I. NRS Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

   a. Crane Co.; Crane Valve Group; Stockham Division.

   b. NIBCO INC.

   c. Tyco Fire & Building Products LP.

2. Standard: UL 262.

3. Pressure Rating: 250 psig (1725 kPa) minimum, or greater as required for project conditions.

4. Body Material: Cast iron with indicator post flange.

5. Stem: Nonrising.

6. End Connections: Flanged or grooved.

J. Indicator Posts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

a. Crane Co.; Crane Valve Group; Stockham Division.

b. NIBCO INC.

c. Tyco Fire & Building Products LP.

2. Standard: UL 789.

3. Type: Horizontal for wall mounting.

4. Body Material: Cast iron with extension rod and locking device.

5. Operation: Wrench or Hand wheel.

2.6 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

2. Pressure Rating: 175 psig (1200 kPa), or greater as required for project conditions.

B. Angle Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

a. Fire Protection Products, Inc.

b. United Brass Works, Inc.

c. AGF Manufacturing.

C. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

a. Milwaukee Valve Company.

b. NIBCO INC.

c. Victaulic Company.

D. Globe Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

a. Fire Protection Products, Inc.

b. United Brass Works, Inc.

c. NIBCO.

E. Plug Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

a. Southern Manufacturing Group.

2.7 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

2. Pressure Rating:

a. Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.

b. High-Pressure Piping Specialty Valves: 250 psig (1725 kPa) minimum, or greater as required for project conditions.

3. Body Material: Cast or ductile iron.

4. Size: Same as connected piping.

5. End Connections: Flanged or grooved.

B. Alarm Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

a. Tyco Fire & Building Products LP.

b. Victaulic Company.

c. Viking Corporation.

d. Reliable.

2. Standard: UL 193.

3. Design: For horizontal or vertical installation.

4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.

5. Drip Cup Assembly: As required per manufacturer's recommendations.

C. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

a. AFAC Inc.

b. Reliable Automatic Sprinkler Co., Inc.

c. Tyco Fire & Building Products LP.

2. Standard: UL 1726.

3. Pressure Rating: 175 psig (1200 kPa), or greater as required for project conditions..

4. Type: Automatic draining, ball check.

5. Size: NPS 3/4 (DN 20).

6. End Connections: Threaded.

7. Install automatic ball drip drain valves horizontally and in accordance with the manufacturer recommendations.

2.8 FIRE-DEPARTMENT CONNECTIONS

A. Exposed-Type, Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, the following:

a. Elkhart Brass Mfg. Company, Inc.

b. Fire-End & Croker Corporation.

c. Potter-Roemer.

2. Standard: UL 405.

3. Type: Exposed, projecting, for wall mounting.

4. Pressure Rating: 175 psig (1200 kPa), or greater as required for project conditions.

5. Body Material: Corrosion-resistant metal.

6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

7. Caps: Brass, lugged type, with gasket and chain.

8. Escutcheon Plate: Round, brass, wall type.

9. Outlet: Back, with pipe threads.

10. Number of Inlets: See drawings.

11. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE AUTO SPKR."

12. Finish: per Owner/Architect.

13. Outlet Size: NPS 4 (DN 100) NPS 5 (DN 125) NPS 6 (DN 150).

B. Flush-Type, Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

   a. Elkhart Brass Mfg. Company, Inc.

   b. Potter Roemer.

   c. Fire-End & Croker Corp.

2. Standard: UL 405.

3. Type: Flush, for wall mounting.

4. Pressure Rating: 175 psig (1200 kPa) minimum, or greater as required for project conditions.

5. Body Material: Corrosion-resistant metal.

6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

7. Caps: Brass, lugged type, with gasket and chain.

8. Escutcheon Plate: Rectangular, brass, wall type.

9. Outlet: With pipe threads.

10. Number of Inlets: See drawings.

11. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE AUTO SPKR."

12. Finish: per Owner/Architect.

13. Outlet Size: See drawings.

C. Yard-Type, Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

   a. Elkhart Brass Mfg. Company, Inc.

   b. Fire-End & Croker Corporation.

2. Standard: UL 405.

3. Type: Exposed, freestanding.

4. Pressure Rating: 175 psig (1200 kPa) minimum, or greater as required for project conditions.

5. Body Material: Corrosion-resistant metal.

6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

7. Caps: Brass, lugged type, with gasket and chain.

8. Escutcheon Plate: Round, brass, floor type.

9. Outlet: Bottom, with pipe threads.

10. Number of Inlets: See drawings.

11. Sleeve: Brass

12. Sleeve Height: 18 inches (460 mm).

13. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE AUTO SPKR."

14. Finish per Owner and Architect.

15. Outlet Size: See drawings.

2.9 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, the following:

   a. Anvil International, Inc.

   b. Tyco Fire & Building Products LP.

   c. Victaulic Company.

2. Standard: UL 213.

3. Pressure Rating: 175 psig (1200 kPa) minimum, or greater as required for project conditions.

4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.

5. Type: Mechanical-T and -cross fittings.

6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.

7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.

8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

   a. AGF Manufacturing Inc.

   b. Tyco Fire & Building Products LP.

   c. Victaulic Company.

   d. Reliable.

2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

3. Pressure Rating: 175 psig (1200 kPa) minimum, or greater as required for project conditions.

4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.

5. Size: Same as connected piping.

6. Inlet and Outlet: Threaded.

C. Branch Line Testers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

a. Elkhart Brass Mfg. Company, Inc.

b. Fire-End & Croker Corporation.

c. AGF Manufacturing Inc.,

2. Standard: UL 199.

3. Pressure Rating: 175 psig (1200 kPa).

4. Body Material: Brass.

5. Size: Same as connected piping.

6. Inlet: Threaded.

7. Drain Outlet: Threaded and capped.

8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

a. AGF Manufacturing Inc.

b. Victaulic Company.

c. Viking Corporation.

d. Reliable.

2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

3. Pressure Rating: 175 psig (1200 kPa) minimum, or greater as required for project conditions.

4. Body Material: Cast- or ductile-iron housing with sight glass.

5. Size: Same as connected piping.

6. Inlet and Outlet: Threaded.

2.10 SPRINKLERS

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

1. Tyco Fire and Building Products.

2. Viking Corporation.

3. Reliable.

4. Victaulic

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

2. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum, or greater as required for project conditions..

3. Pressure Rating for High-Pressure Automatic Sprinklers or greater as required for project conditions.250 psig (1725 kPa) minimum 300 psig (2070 kPa).

C. Open Sprinklers with Heat-Responsive Element Removed: UL 199.

D. Sprinkler Finishes:

1. Finishes per Architect/Owner unless otherwise noted on the drawings.

2. Corrosion-resistant finishes where required per project conditions.

E. Sprinkler Escutcheons: Materials, types, and finishes shall be per manufacturer's required. applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers. Finishes per Architect and Owner.

F. Sprinkler Guards:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Tyco Fire & Building Products LP.

b. Victaulic Company.

c. Viking Corporation.

d. Reliable.

2. Standard: UL 199.

3. Type: Wire cage with fastening device for attaching to sprinkler.

4. Sprinkler guards shall be cross-listed with the sprinkler used.

2.11 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Tyco Fire & Building Products LP.

b. Victaulic Company.

c. Viking Corporation.

d. Reliable.

2. Standard: UL 753.

3. Type: Mechanically operated, with Pelton wheel.

4. Alarm Gong: Cast aluminum with red-enamel factory finish.

5. Size: 10-inch (250-mm) diameter, or as required.

6. Components: Shaft length, bearings, and sleeve to suit wall construction.

C. Electrically Operated Alarm Bell:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

a. Fire-Lite Alarms, Inc.

b. Notifier

c. Potter Electric Signal Company.

2. Standard: UL 464.

3. Type: Vibrating, metal alarm bell.

4. Size: 6-inch (150-mm) minimum or as required.

5. Finish: Red-enamel factory finish, suitable for outdoor use.

D. Water-Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

   a. Potter Electric Signal Company.

   b. System Sensor

2. Standard: UL 346.

3. Water-Flow Detector: Electrically supervised.

4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

5. Type: Paddle operated, including retard feature.

6. Pressure Rating: 250 psig (1725 kPa), or greater as required for project conditions.

7. Design Installation: Horizontal or vertical and as required per manufacturer's recommendations.

E. Pressure Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

   a. Potter Electric Signal Company.

   b. System Sensor; a Honeywell company.

2. Standard: UL 346.

3. Type: Electrically supervised water-flow switch with retard feature.

4. Components: Single-pole, double-throw switch with normally closed contacts.

5. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

   a. Potter Electric Signal Company.

   b. System Sensor; a Honeywell company.

2. Standard: UL 346.

3. Type: Electrically supervised.

4. Components: Single-pole, double-throw switch with normally closed contacts.

5. Design: Signals that controlled valve is in other than fully open position.

G. Indicator-Post Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

a. Potter Electric Signal Company.

b. System Sensor.

2. Standard: UL 346.

3. Type: Electrically supervised.

4. Components: Single-pole, double-throw switch with normally closed contacts.

5. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.12 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

1. AMETEK; U.S. Gauge Division.

2. Ashcroft, Inc.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.

D. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum.

E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping at the service entrance to the building.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with the requirements for backflow preventers as per the local utility company and authority having jurisdiction.

3.3 WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to building's interior fire service piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Section 22 11 19 "Domestic Water Piping Specialties."

3.4 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

J. Install alarm devices in piping systems.

K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

M. Pressurize and check pre-action sprinkler system piping and air-pressure maintenance devices and air compressors as required.

N. Fill sprinkler system piping with water.

O. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with the NPFA, local codes, manufacturer requirements and the specifications for heating cables and insulation.

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 21 05 17 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 21 05 18 "Escutcheons for Fire-Suppression Piping."

S. Provide pressure reducing valves (PRVs) where the static system pressures exceed 175 psi and also where required to balance the system pressures. Install PRVs and provide all accessories and appurtenances in accordance with NFPA 13 and the local codes. The actual static pressure must be determined for the project based on the available maximum static street pressure and the installed equipment.

3.5 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.

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

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems. Provide dielectric separation as required.

3.6 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and with NFPA 13 for supports.

3.7 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3. Deluge Valves: Install in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

E. Provide fire alarm system connections as required. Coordinate all connections with the fire alarm contractor.

F. Install all valves in accessible locations as required by NFPA.

3.8 SPRINKLER INSTALLATION

A. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

B. Provide sprinkler guards where sprinkler heads are located 7’ – 0” AFF or where heads are subject to damage.

3.9 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire-department connections.

B. Install yard-type, fire-department connections in concrete slab support. Comply with requirements for concrete in Section 03 30 00 "Cast-in-Place Concrete."

1. Install protective pipe bollards around each fire-department connection. Comply with requirements for bollards in Section 05 50 00 "Metal Fabrications."

C. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.10 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Flush, test, and inspect sprinkler systems in accordance with to NFPA 13 requirements.

4. Energize circuits to electrical equipment and devices.

5. Coordinate with fire-alarm tests. Operate as required.

6. Coordinate with fire-pump tests. Operate as required.

7. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.12 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.13 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves , pumps and all other equipment.

3.14 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Wet-pipe sprinkler systems, NPS 2 (DN 50) and smaller, shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

3. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

D. Wet-pipe sprinkler systems, NPS 2-1/2 and larger (DN 65 and larger), shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

3. Standard-weight, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

4. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

5. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

6. Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints. The use of Schedule 10 is permitted downstream of the floor control valve only. Schedule 10 is not permitted on cross mains and risers.

7. Schedule 10, black-steel pipe with plain ends; welding fittings; and welded joints. The use of Schedule 10 is permitted downstream of the floor control valve only. Schedule 10 is not permitted on cross mains and risers.

3.15 SPRINKLER SCHEDULE (REFER TO SCHEDULE ON DRAWINGS)

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings and MERs: Upright sprinklers.

2. Rooms with Suspended Ceilings: Concealed pendent sprinklers.

3. Wall Mounting: Sidewall sprinklers.

4. Spaces Subject to Freezing: Upright sprinklers, Pendent dry sprinklers, Sidewall dry sprinklers, as indicated.

5. Special Applications: Extended-coverage and flow-control where indicated.

6. All sprinklers in Light Hazard occupancies as defined by NFPA 13 shall be quick response.

7. Coordinate sprinkler head temperature ratings with the requirements of NFPA 13. Provide sprinkler head temperature ratings in accordance with NFPA 13 for sprinklers in the vicinity of heat sources and skylights.

8. Sprinkler finishes subject to Owner’s and/or Architect’s approval.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.

2. Flush Sprinklers: Bright chrome, with painted white escutcheon.

3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.

4. Upright Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 21 13 13

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DIVISION 22 - PLUMBING INDEX

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SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. The system shall include but not limited to the following: All plumbing fixtures, roughing and accessories, piping, insulation, fittings, valves, strainers, pumps, water distribution, water heaters, storm and sanitary drainage, sanitary vents, interceptors, gauges, thermometers, equipment and piping identification.

B. This Section includes general administrative and procedural requirements for the plumbing installations. The administrative and procedural requirements included in this section expand the requirements specified in Division 01.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and the other sections of Division 22.

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

1. Sustainable design Requirements – Division 01

2. Site Utilities – Division 02 “Site Work”.

3. Cast-in Place Concrete - Division 03 -“Concrete”

4. Metal Fabrications - Division 05-“Metals”

5. Firestopping-Division 07 -“Thermal and Moisture Protection”

6. Flashing Wall and Roof Penetrations - Division 07 - “Thermal and Moisture Protection”

7. Sealants and Caulking - Division 07 - “Thermal and Moisture Protection”

8. Painting – Division 09 – “Finishes”

9. Division 21 – Fire Protection

10. Division 22 - Plumbing

11. Division 23 – Heating, Ventilation, and Air Conditioning

12. Division 26 – Electrical

13. Excavation and Backfill – Division 31 – “Earthwork”

1.3 CODES, PERMITS AND INSPECTIONS

A. All work shall meet or exceed the latest requirements of all national, state, county, municipal and other authorities exercising jurisdiction over construction work at the project.

B. It shall be understood that the requirements of the specifications and drawings are complimentary to the requirements delineated elsewhere in the code or by the authorities exercising jurisdiction over the project. Nothing on the drawings and specifications shall be interpreted as reason to waive the applicable code requirements. Installed work identified as having code deficiencies shall be replaced at the contractor's expense.

C. All required permits, approval and inspection certificates shall be obtained, paid for, and made available at the completion of the work, by the Plumbing Contractor.

D. Installation procedures, methods, and conditions shall comply with the latest requirements of The Federal Occupational Safety and Health Act (OSHA).

E. Prepare and submit to the building department a set of "as-built" record drawings for approval, in a form acceptable to the building department.

F. The Contractor shall be responsible for the installation and filing until the installation has been approved by the authorities having such jurisdiction.

G. Comply with all owner requirements and all bright horizons requirements.

H. The Contractor shall be responsible for the installation and filing until the installation has been approved by the authorities having such jurisdiction.

1.4 GUARANTEES AND CERTIFICATIONS

A. All work shall be guaranteed to be free from leaks and defects. Any defective materials or workmanship, as well as damage to the work of all trades resulting from same, shall be replaced or repaired as directed for the duration of stipulated guaranteed periods.

B. The duration of guarantee periods following the date of beneficial use of the system shall be one year. Beneficial use is defined as operation of the system to obtain its intended use.

C. The date of acceptance shall be the date of the final payment for the work or the date of a formal notice of acceptance, whichever is earlier.

D. Non-durable replaceable items, such as water filter media, do not require replacement after the date of acceptance. If received in writing, requests to have earlier acceptance dates established for these items will be honored.

E. Certification shall be submitted attesting to the fact that specified performance criteria are met by all items of plumbing equipment.

1.5 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. Piping: Pipe, fittings, flanges, valves, controls, hangers, drains, insulation, and items customarily required in connection with the transfer of fluids.

G. By Other Trades: By persons or parties responsible for work at the project other than the party or parties who have been duly awarded the contract for the work of this Trade. In the event that this document is used to acquire work as part of a general construction contract the words “by other trades” shall mean by persons or parties who are not anticipated to be the sub-contractor for this trade working together with the general contractor. In this context the words “by other trades” shall not be interpreted to mean not included in the overall contract.

H. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.

2. CPVC: Chlorinated polyvinyl chloride plastic.

3. PE: Polyethylene plastic.

4. PVC: Polyvinyl chloride plastic.

I. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.

2. NBR: Acrylonitrile-butadiene rubber.

1.6 SUBMITTALS

A. In accordance with Division 01, SUBMITTAL PROCEDURES, furnish the following:

B. Prior to purchasing any equipment or materials, a list of their manufacturers shall be submitted for approval.

C. Prior to assembling or installing the work, the following shall be submitted for approval:

1. Scale drawings indicating insert and sleeve locations if required by Architect or Structural Engineer.

2. Scale drawings showing all piping runs with sizes, elevations and appropriate indication of coordination with other trades. This submission shall consist of one (1) electronic file and two (2) paper prints.

3. Catalog/internet information, factory assembly drawings and field installation drawings as required for a complete explanation and description of all items of equipment.

4. Coordination drawings for access panels and door locations

5. Welder Certificates signed by the Contractor certifying that welders comply with requirements specified under "Quality Assurance" in this section.

D. Documents for equipment and materials will not be accepted for review unless:

1. They include complete information pertaining to appurtenances and accessories.

2. They are submitted as a package where they pertain to related items.

3. They are properly marked with service or function, project name, where they consist of catalog sheets displaying other items which are not applicable.

4. They indicate the project name and address along with the Contractor's name, address and phone number.

5. They are properly marked with external connection identification as related to the project where they consist of standard factory assembly or field installation drawings.

E. Shop Drawing Review

1. The purpose of the review of shop drawings is to maintain integrity of the design. Unless the contractor clearly points out changes, substitutions, deletions or any other differences between the submission and the Contract Documents in writing on the Contractor's letterhead, approval by the Engineer or Architect does not constitute acceptance. It is not to be assumed that the engineer has read the text nor reviewed the technical data of a manufactured item and its components except where the Vendor has pointed out differences between his product and the specified model.

2. Upon receipt of the approved manufacturers and material suppliers list, the Contractor shall immediately obtain complete Shop Drawings, Product Data and Samples and equipment and material Specification Compliance Review documents from the manufacturers, suppliers, vendors and all Division 22 Contractors, for all materials and equipment as specified herein in various sections of the specifications and shall submit data and details of such materials and equipment for review by the Architect and Engineer. Prior to submission of the Shop Drawings, Product Data and Samples to the Architect and Engineer, the Contractor shall thoroughly review the Shop Drawings, Product Data and Samples and certify they are in compliance with the Contract Documents. The Contractor shall provide a compliance review ("Compliance Review") of the applicable Drawings, Specifications and Addenda for all equipment and materials. The Compliance Review will be a paragraph by paragraph review of the Specifications with the following information marked for each Specification section paragraph or in the margin of the original Specification and any subsequent Addenda.

   a. "C": Comply with no exceptions.

   b. "D": Comply with minor deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.

   c. "E": Exception. Equipment, product or material does not comply. For each and every exception, provide a numbered footnote with reasons for each exception and suggest possible alternatives for the owner's consideration.

   d. "N/A": The specification paragraph does not apply to the proposed equipment, material or product.

   e. Unless a deviation or exception is specifically noted in the Compliance Review, it is assumed that the Contractor is in complete compliance with the Contract Documents. Deviations or exceptions taken in cover letters, subsidiary documents, by omission or by contradiction does not relieve the Contractor from being in complete compliance unless the exception or deviation has been specifically noted (explicitly, not by implication) in the Compliance Review.

3. It is the responsibility of the contractor to confirm all dimensions, quantities, and the coordination of materials and products supplied by him with other trades. Approval of shop drawings containing omissions improper coordination does not relieve the contractor from making corrections at his expense.

4. Substitutions of equipment, systems, materials, must be coordinated by the Contractor with his own or other trades which may be involved with the item, such as, but not limited to, equipment substitutions which change electrical requirements, or hanging or support weights or dimensions.

5. Any extra charges or credits which may be generated by other trades due to substitutions will not be accepted unless the Contractor has an agreement in writing with the Owner.

6. Substitutions of equipment, systems, etc. requiring approval of local authorities must comply with such regulations and be filed at the expense of the Contractor (should filing be necessary). Substitutions are subject to approval or disapproval by the Engineer. The Contractor in offering substitutions shall hold the Owner and Engineer harmless if the substituted item is an infringement of patent held by the specified item.

7. Any proposed substitution submitted for review, must be accompanied by additional documentation indicating all the differences between the specified materials or equipment and the proposed substitution. Substitutions submitted for review without supporting documentation will be returned as Incomplete – Resubmit.

8. Alternate materials or manufacturers of equipment will be considered only if the contractor submits detailed information and appropriate credit for the substitution at the time of bid opening. These detailed proposals, must include sufficient catalog information, including differences, efficiencies, dimensions, warranties and major component identification for proper evaluation of the alternate proposed. No alternate system by another manufacturer will considered prior to considering alternate equipment of the specified manufacturer.

9. Shop drawing review by the engineer, does not constitute reason to waive applicable code requirements. Work identified as having code deficiencies shall be replaced at the contractor's expense.

F. Explanation of Shop Drawing Stamp

1. Reviewed - No Exception Taken: indicates that we have not found any reason why this item should not be acceptable within the intent of the contract documents.

2. Exception Taken As Noted: indicates that we have found questionable components which if corrected or otherwise explained make the product acceptable.

3. Revised and Resubmit: indicates that this item should be resubmitted for review before further processing.

4. Resubmit Specified Item: indicates that the item will not meet the intent of the Contract.

5. Incomplete - Resubmit: Indicates that the submission is not complete and ready for review by the Architect or Engineer.

6. Verified for Electrical Services: Indicates that the electrical requirements has been confirmed with the electrical contract documents.

7. Architects Approval Required: Indicates that the submission will require the Architects review.

8. Structural Approval Required: Indicates that the submission will require the Structural Engineer's review.

9. Acoustical Consultant Review Required: Indicates that the submission will require the Acoustical Consultant's review

10. No shop drawing stamp or note shall constitute an order to fabricate or ship. Such notification can only be performed by the Project Manager for Construction, the Contractor scheduling his own work, or the Owner.

11. The Contractor is responsible for having "Reviewed" copies of shop drawings bearing the "Reviewed - No Exception Taken" stamp of the Architect/Engineer or Owner's Consultant are kept on the job site and work is implemented in the field in accordance with these documents.

12. Where information from one Contractor is required by another contractor, it is the responsibility of the contractors to exchange information and coordinate their work.

1.7 MAINTENANCE DATA AND OPERATING INSTRUCTIONS

A. Maintenance and operating manuals in accordance with Division 01, for systems and equipment.

B. After all final tests and adjustments have been completed, fully instruct the proper Owner's Representative in all details of operation for equipment installed. Supply qualified personnel to operate equipment for sufficient length of time to assure that Owner's Representative is properly qualified to take over operation and maintenance procedures. Supply qualified personnel to operate equipment for sufficient length of time as required to meet all governing authorities in operation and performance tests.

C. Furnish required number of manuals, in bound form containing data covering capacities, maintenance of operation of all equipment and apparatus. Operating instruction shall cover all phases of control and include the following:

1. Performance Curves: For pumps and similar equipment at the operating conditions.

2. Lubrication Schedule: Indicating type and frequency of lubrication required.

3. List of Spares: Recommended for normal service requirements.

4. Parts List: Identifying the various parts of the equipment for repair and replacement purposes.

5. Instruction Books may be standard booklets but shall be clearly marked to indicate applicable equipment.

6. Wiring Diagrams: Generalized diagrams are not acceptable, submittal shall be specifically prepared for this Project.

7. Automatic Controls: Diagrams and functional descriptions.

D. Where applicable, one set of operating and maintenance instructions shall be neatly framed behind glass and securely hung adjacent to the equipment concerned.

E. Welding certificates. Submit welding certificates as specified herein.

1.8 DELIVERY, STORAGE, HANDLING AND PROTECTION

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Unit shall be stored and handled in accordance with manufacturer's instructions.

C. Unit shall be shipped with all listed items and control wiring factory installed unless noted on the submittals and approved prior to shipment.

D. Unit shall be shipped complete as specified. Parts for field installation shall not be shipped and stored on site without prior approval.

E. Rigging: Units shall be fully assembled. Units requiring disassembly for rigging shall be factory assembled and tested. Disassembly, reassembly and testing shall be supervised by the manufacturer's representative.

F. Unit shall be shipped with firmly attached labels that indicate name of manufacturer, model number, serial number, date of manufacturer, capacity information and plan tagging.

G. Deliver, store and handle all materials to keep clean and protected from damage.

H. Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

I. Protect flanges, fittings, and piping specialties from moisture and dirt.

J. Protect stored plastic pipes and materials from direct sunlight and excessive heat. Support to prevent sagging and bending.

K. Protect equipment and other materials from damage after installed from construction debris and other damage.

L. This trade shall be responsible for its work and equipment until finally inspected, tested and accepted. Carefully store materials and equipment which are not immediately installed after delivery to site. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing material.

M. This trade shall protect work and material of other trades from damage that might be caused by its work or workmen and make good damage thus caused.

1.9 PRE-CONSTRUCTION CONFERENCE PRIOR TO START OF WORK

A. Prior to commencing any Work, the Construction Manager, together with designated major Contractors, shall confer with the Architect and Engineer concerning the Work under the Construction Contract.

B. The pre-construction conference will be conducted under the leadership of the CM and will occur soon after the CM notifies the Subcontractors of contract award. The pre-construction conference will focus on items such as the expedited submittal review procedure, interface and coordination between Contractor work scope, the CM's project site rules and requirements, temporary utility requirements, CM's construction schedule, etc.

1.10 SEQUENCING AND SCHEDULING

A. Coordinate plumbing equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for plumbing installations.

C. Coordinate the installation of required supporting devices and set sleeves in poured in place concrete and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

E. Coordinate connection of electrical services prior to purchasing equipment.

F. Coordinate connection of plumbing systems with existing and new exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

G. Coordinate requirements for access panels and doors where plumbing items requiring access are concealed behind finished surfaces. See paragraph titled “Separation of Work Between Trades” to determine whether access panels and doors the responsibility of the Contractor for Division 08 or the Contractor responsible for Division 22.

H. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

1.11 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces.

D. Provide all designating signs for shutoff valves, control valves, alarms, and the like, as required by the agencies having jurisdiction.

1.12 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 01 Section titled "PROJECT COORDINATION," to a scale of 3/8"=1'-0" or larger; detailing major elements, components, and systems of plumbing equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work:

1. The coordination drawings shall be produced using AutoCad 2011 or later software. The design drawings will be made available on disks in AutoCad format for use as a basis for the "Coordination" drawings. These documents remain the property of Cosentini Associates and shall be used for no other purpose without expressed, written consent. The contractor shall assume all liabilities resulting from unauthorized use or modifications to the drawings.

2. Indicate the proposed locations of piping, equipment, and materials. Include the following:

   a. Planned piping layout, including valve and specialty locations and valve stem movement.

   b. Clearances for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.

   c. Equipment connections and support details.

   d. Exterior wall and foundation penetrations.

   e. Fire-rated wall and floor penetrations.

   f. Sizes and location of required concrete pads and bases.

   g. Clearances as required by Electric Code.

3. Indicate piping loads and support points for all piping 4" and larger, racked piping, and submit to the Structural Engineer for review and approval. Indicate the elevation, location, support points, and loads imposed on the structure at support, anchor points, and size of all lines. Indicate all beam penetrations and slab penetrations sized and coordinated. Indicate all work routed underground or embedded in concrete by dimension to column and building lines.

4. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

5. Prepare floor plans, elevations and details to indicate penetrations in floors, walls and ceilings and their relationship to other penetrations and installation.

6. Prepare reflected ceiling plans to coordinate and integrate sprinkler installations, air outlets and inlets, light fixtures, communication systems components and other ceiling-mounted items.

B. Plumbing Coordination Drawings

1. This trade shall add to Coordination Drawings prepared by the HVAC Contractor showing all of the plumbing work (equipment, piping, etc.) to be installed as part of the work of this section of the specifications.

2. The Coordination Drawings shall be prepared on electronic media (CADD) at not less than 3/8": 1'-0" scale.

3. This Trade after showing all of the plumbing work shall forward the reproducible Coordination Drawings to the Electrical or Fire Protection Contractor.

4. The sequence of coordination drawings shall be HVAC-PLBG-FP-ELEC-CM/GC.

5. The Plumbing Contractor shall attend a series of meetings arranged by the General Contractor/Construction Manage to resolve any real or apparent interferences or conflicts with the work of the other Contractors.

6. The Plumbing Contractor shall then make adjustments to his work on the Coordination Drawings to resolve any real or apparent interferences or conflicts.

7. After any real or apparent interferences and conflicts have been incorporated into the Coordination Drawings, the Plumbing Contractor shall "sign-off" the final Coordination Drawings.

8. The Plumbing Contractor shall not install any of his work prior to "sign-off" of final Coordination Drawings. If the plumbing work proceeds prior to sign-off of Coordination Drawings, any change to the plumbing work to correct the interferences and conflicts which result will be made by the Plumbing Contractor at no additional cost to the project.

9. Coordination Drawings are for the Contractor's and Architects use during construction and shall not be construed as replacing any shop "as-built", or Record Drawings required elsewhere in these Contract Documents.

10. Architect's review of Coordination Drawings shall not relieve Contractor from his overall responsibility for coordination of all work performed pursuant to the Contract or from any other requirements of the Contract.

1.13 RECORD DRAWINGS

A. Prepare record documents in accordance with the requirements in Division 1. In addition to the requirements specified in Division 1, comply with the following.

1. A complete set of "as-built" or record drawings shall be made up and delivered to the Architect.

B. The drawings shall show:

1. All work installed exactly in accordance with the original design.

2. All installed as a modification or addition to the original design.

3. The dimensional information necessary to delineate the exact location of all piping runs which are so concealed as to be untraceable by inspection through the regular means of access established for inspection and maintenance.

C. This trade shall submit the "as-built" set for approval by the building department, when required by the jurisdiction.

D. The drawings shall be produced using AutoCad 2011 or later software. The design drawings will be made available on disks in AutoCad format for use as a basis for the "as-built" drawings. These documents remain the property of Cosentini Associates and shall be used for no other purpose without expressed, written consent. The contractor shall assume all liabilities resulting from unauthorized use or modifications to the drawings. Prior to developing any "as-built" drawings, the contractor shall coordinate with the Owner and the Architect and Engineer the drawing layers, colors, etc., of the CAD drawings. "As-built" information shall be submitted as follows:

1. CAD drawing files on disks in AutoCad 2011 format.

2. Two (2) sets of printed drawings.

E. Where shop drawings have been prepared and approved, the "as-built" drawings shall be cross referenced to the respective shop drawing.

F. As-built record drawings shall include the updating of all equipment schedule sheets

G. The record drawings shall be of legible reproducible and durable type.

H. The quantity of design drawings which are made available shall in no way be interpreted as setting a limit to the number of drawings necessary to show the required "as-built" information.

I. Progress prints of record drawings shall be submitted monthly during the construction period for Architect's approval.

J. This trade shall submit the "as-built" set for approval by the Engineer in a form acceptable to the Engineer.

K. Final acceptance of the fire protection systems by the authority having jurisdiction will not be implemented until "as-built" drawings are on site.

L. As-built drawings for filing with the Building Department (where required) shall be prepared at the same scale, in the same plan format and use the same symbols and nomenclature as the plans filed by Engineer of Record with the Building Department for “Building Permit.”

1.14 INTERPRETATION OF THE DRAWINGS AND SPECIFICATIONS

A. As used in the drawings and specifications, certain non-technical words shall be understood to have specific meanings as follows:

1. "Furnish"----------Purchase and deliver to the project site complete with every necessary appurtenance and support.

2. "Install"----------Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project.

3. “Provide"----------"Furnish" and "Install".

B. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether this instruction is explicitly stated as part of the indication or description.

C. It shall be understood that the specifications and drawings are complementary and are to be taken together for a complete interpretation of the work. Where there are conflicts between the drawings and specifications or within the specifications or drawings themselves, the items of higher standard shall govern.

D. No exclusions from, or limitations, in the language used in the drawings or specifications shall be interpreted as meaning that the appurtenances or accessories necessary to complete any required system or item of equipment are to be omitted.

E. The drawings of necessity utilize symbols and schematic diagrams to indicate various items of work. Neither of these have any dimensional significance nor do they delineate every item required for the intended installations. The work shall be installed, in accordance with the diagrammatic intent expressed on the drawings, and in conformity with the dimensions indicated on final architectural and structural working drawings and on equipment shop drawings.

F. No interpretation shall be made from the limitations of symbols and diagrams that any elements necessary for complete work are excluded.

G. Certain details appear on the drawings which are specific with regard to the dimensioning and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the indicated work.

H. Information as to the general construction shall be derived from structural and architectural drawings and specifications only.

I. The use of words in the singular shall not be considered as limiting where other indications denote that more than one item is referred to.

J. In the event that extra work is authorized, and performed by this trade, work shown on drawings depicting such work, and/or described by Bulletin is subject to the base building specifications in all respects.

1.15 SEPARATION OF WORK BETWEEN TRADES

A. The Specifications for the overall construction delineate various items of work under separate trade headings. The list below sets forth this delineation to the extent that it affects the Plumbing Work.

B. In the absence of more detailed information, this list shall be taken as a specific instruction to the Plumbing trade to include the work assigned to it.

C. Indications that the Plumbing trade is to perform an item of work mean that it is to perform the work for its own accommodation only, except as specifically noted otherwise.

D. Oth = Divisions other than Electrical (Division 26); Mechanical (Divisions 21, 22 & 23)

Plb = Plumbing

FP = Fire Protection

Htg = Heating, Ventilating & Air Conditioning

Elec = Electrical

f = Furnished

I = Installed

p = Provided (furnished and installed)

Item	Oth	Plb	Fp	Htg	Elec	Notes
Motors for plumbing equipment		p				
Motor controls for plumbing equipment		f			I	Specifications and drawings delineate detailed exceptions.
Power wiring for plumbing equipment motors & motor controls					p	Specifications and drawings delineate detailed exceptions.
Temporary heat	p					
Temporary water	p					
Temporary light & power	p					

Item	Oth	Plb	Fp	Htg	Elec	Notes
Temporary toilets	p					
Hoisting	p					
Rigging	p					
Bracing of building for safe rigging		p				
Cutting, chasing & patching	p					Cost where due to late installation or improper coordination of work is the responsibility of the delinquent trade.
Framed slots and openings in walls, decks and slabs	p					
Sleeves through slabs, decks and walls		p				
Sleeves through membraned and waterproofed slabs, decks and walls		p				For piping penetrating foundation walls and footings, the sleeve shall be 2 sizes greater than the penetrating pipe.
Waterproof sealing of pipes passing through sleeves		p				
Waterproof sealing of sleeves through membraned and water proofed slabs, decks and walls		p				
Fireproof sealing of excess openings in slabs, decks & fire rated walls		p				
Excavation and backfill inside buildings	p					
Excavation and backfill outside buildings	p					
Keeping site and excavations free from water during construction	p					To accommodate the overall project.
Fastenings		p				
Supports		p				
Concrete encasement of underground runs	p					

Item	Oth	Plb	Fp	Htg	Elec	Notes
Subsoil drainage inside building (footing drains)	p					Connection to the sand interceptor by this trade, including backwater valve.
Floor drain flashing		p				
Base flashing for roof drains and all piping penetrating roof	p					
Cap flashing for all piping penetrating roof		p				
Concrete foundations, pads and bases	p					Plumbing Contractor to furnish sizes and locations. Furnishing of anchors and vibration mounts included in the Plumbing Contractor.
Trenches in building foundation	p					
Field touch up painting of damaged shop coats		p				
Prime coating hangers & supports		p				
Rustproofing field cut and assembled iron supporting frames and racks		p				
Finished painting	p					
Finished Wall and Ceiling Access Doors and Supporting Frames	p					Supplying list locating all required access doors (none to be less than 16” x 16”) included in Plumbing.
Catwalks to plumbing equipment	p					Supplying list of locations where required included in the Plumbing Contractor.

Item	Oth	Plb	Fp	Htg	Elec	Notes
Ladders to equipment and valves	p					Supplying list of locations where required to be installed by the Plumbing Contractor
Domestic make-up water piping for heating and air conditioning systems including backflow preventer		p				Final equipment connections included in heating trade.
Toilet room accessories	f					Install certain toilet room accessories as required by local trade union jurisdiction.
Plumbing fixtures, roughing and accessories		p				
Food service equipment	p					Plumbing Contractor to provide roughing and final connections.
Rubbish removal		p				Where one trade furnishes and another installs, the installing trade removes the shipping and packing materials which accumulate.
Special tools for equipment maintenance		p				
Laundry equipment	p					Plumbing Contractor to provide roughing and final connections.
Balance hot water recirculation system(s)		p				Plumbing Contractor to provide equipment and labor. Provide balancing valves on all hot water return lines. Balance the system prior to the building opening.
Domestic and Fire water services up to five feet from the building, including valve & valve box. To capped OS&Y valve connection & water meter inside building		p				
Electric heating cables for pipe tracing – freeze protection.					p	Insulation over heat tracing by Plumber.

Item	Oth	Plb	Fp	Htg	Elec	Notes
Electric heating cables for pipe tracing – Hot Water Temperature Maintenance - HWAT		p				Coordinate insulation and installation requirements with the heat tracing manufacturer.
Electric heating cables for pipe tracing – Kitchen Grease Waste Lines Temperature Maintenance upstream of the grease interceptor.		p				Coordinate insulation and installation requirements with the heat tracing manufacturer. Include for all kitchen waste lines upstream of the grease interceptor.
Expansion tanks for the domestic hot water preparation system.		p				Provide for each zone sized to prevent exceeding the maximum working pressure. Expansion tank cannot be supported by the piping. Provide structural supports.
Expansion compensators/loops		p				Provide an engineered system for all metallic pipe in accordance with the specifications. For plastic piping follow the manufacturer recommendations.
Trap primers		p				Provide trap primers connected to the water supply for all drains that require it in accordance with the code.
Water Hammer Arrestors		p				Provide water hammer arrestors for all the fast closing valves, fixtures and appliances as indicated on the drawings and where required by code.
Tests		p				Contractor must perform all tests required by code for all installed piping. Coordinate the testing with the construction progress (i.e. piping must be tested at the required pressures before the equipment and fixtures are installed and the walls closed).

Item	Oth	Plb	Fp	Htg	Elec	Notes
Air vents		p				Provide automatic air vents for all the high points of the domestic water system.
Vacuum relief valves		p				Provide vacuum relief valves on the cold water supply to each water heater.
Wiring for pumps		p				Provide all wiring required for the pumping systems including control wiring in conduit and wiring from remote sensors, tank fill panels, alarms, etc.
Domestic Water Filters and Pump Controls		p				Provide controls and wiring as required between domestic water pumps and domestic water filters in order ensure proper pump/filter operation.
Mixing Valves		p				Provide master mixing valves for each hot water distribution zone. Provide anti scald measures for all master mixing valves. Coordinate with manufacturer requirements.
Back Water Valves		p				Provide back water valves for all sanitary and storm connections as required by code and for buildings in located flood zones.
Shut-off valves at pressure reducing valve rigs		p				Provide a master shut-off valve before every pressure reducing valve rig.
Kitchen sink waste lines		p				Provide min 2” kitchen sink waste lines.
Backflow preventer for beverage machines, coffee machines		p				Provide backflow preventers conforming to ASSE 1022.

Item	Oth	Plb	Fp	Htg	Elec	Notes
Anchorage to restrain drainage piping (sanitary, waste and storm) from axial movement		p				Provide at the base of all stacks and leaders regardless of size. Provide for pipe sizes greater than 4" at all changes in direction and at all changes in diameter greater than two pipe sizes.

E. The Plumbing Contractor is required to supply all necessary supervision and coordination information to any other trades who are to supply work to accommodate the Plumbing installation.

F. Where the Plumbing Trade is required to install items which it does not purchase, it shall include for such items:

1. The coordination of their delivery.

2. Their unloading from delivery trucks driven in to any designated point on the property line at grade level.

3. Their safe handling and field storage up to the time of permanent placement in the project.

4. The correction of any damage, defacement or corrosion to which they may have been subjected.

5. Their field assembly and internal connection as may be necessary for their proper operation.

6. Their mounting in place including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt them to architectural and structural conditions.

7. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

8. Items which are to be installed but not purchased as part of the work of the Plumbing Contractor shall be carefully examined by this trade upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of the Plumbing Contractor will be considered only if presented in writing within one week of the date of delivery to the project of the items in question. The work of the Plumbing Contractor shall include all procedures, regardless of how extensive, necessary to put into satisfactory operation, all items for which no claims have been submitted as outlined above.

1.16 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

Reference	Definition
ASTM	American Society for Testing Materials
ASPE	American Society of Plumbing Engineers
NFPA	National Fire Protection Association
UL	Underwriters Laboratories, Inc.
NEMA	National Electrical Manufacturers Assn.
FM	Factory Mutual
USAS	United States of America Standards Institute
ANSI	American National Standards Institute
AWWA	American Water Works Association
I.S.O.	Insurance Services Organization
C.S.	Commercial Standards issued by the United States Department of Commerce.
M.S.S.	Manufacturers Standardization Society of the Valve and Fittings Industry
A.G.A.	American Gas Association, Inc.
A.S.H.R.A.E.	American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
P.D.I.	Plumbing and Drainage Institute
N.S.F.	National Sanitation Foundation
A.S.S.E.	American Society of Sanitary Engineering
I.A.P.M.O.	International Association of Plumbing and Mechanical Officials
C.I.S.P.I.	Cast Iron Soil Pipe Institute
DEP	Department of Environmental Protection

1.17 GUARANTEES AND CERTIFICATIONS

A. All work shall be guaranteed to be free from leaks or defects. Any defective materials or workmanship as well as damage to the work of all trades resulting from same shall be replaced or repaired as directed for the duration of stipulated guaranteed periods.

B. The duration of guarantee periods following the date of beneficial use of the system shall be one year. Beneficial use is defined as operation of the system to obtain its intended use.

C. The date of acceptance shall be the date of the final payment for the work or the date of a formal notice of acceptance, whichever is earlier.

D. Certification shall be submitted attesting to the fact that specified performance criteria are met by all items of Plumbing equipment.

1.18 EXAMINATION OF SITE AND CONTRACT DOCUMENTS

A. Before submitting prices or beginning work, thoroughly examine the site and the Contract Documents.

B. No claim for extra compensation will be recognized if difficulties are encountered which examination of site conditions and Contract Documents prior to executing Contract would have revealed.

1.19 WORKMANSHIP

A. The entire work provide in this Specification shall be constructed and finished in every aspect in a workmanlike and substantial manner.

B. It is not intended that the Drawings shall show every pipe, fitting and appliance. Plumbing Contractor shall furnish and install all such parts as may be necessary to complete the systems in accordance with the best trade practice.

C. Keep other trades fully informed as to shape, size and position of all openings required for apparatus and give full information to the General Contractor and other trades in a timely manner so that all opening may be built in advance. Furnish and install all sleeves, supports and the like as specified or as required.

D. In case of failure on the part of the Plumbing Contractor to give proper and timely information as required above, he shall do his own cutting and patching or have same done by the General Contractor, but in any case, without extra expense to the Owner.

E. Obtain detailed information from the manufacturers of apparatus as to the proper method of installing and connecting same. Obtain all information from the General Contractor and other trades which may be necessary to facilitate work and completion of the whole project.

1.20 QUALITY ASSURANCE

A. Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code Steel."

B. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions of ASME B31 Series "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

C. Products Criteria

1. All equipment furnished as part of the work shall comply with the latest editions of all applicable state and municipal energy codes. Provide certification from the equipment suppliers for all energy-consuming equipment that the equipment fully complies with these codes. Equipment submissions will not be accepted for review unless accompanied by such certification in writing.

2. All equipment and materials shall be new and without blemish or defect.

3. New equipment and materials shall be Underwriters Laboratories, Inc. (U.L.) labeled and/or listed where specifically called for or where normally subject to such U.L. labeling and/or listing services.

4. Asbestos

All equipment and materials shall be free of asbestos.

5. Electrical equipment and materials shall be products which will meet with the acceptance of the agency inspecting the electrical work. Where such acceptance is contingent upon having the products examined, tested and certified by Underwriters or other recognized testing laboratory, the product shall be examined, tested and certified. Where no specific indication as to the type or quality of materials or equipment is indicated, a first-class standard article shall be furnished.

6. It is the intent of these specifications that wherever a manufacturer of a product is specified, and the terms "other approved" or "or approved equal" or "equal" are used, the substituted item must conform in all respects to the specified item. Consideration will not be given to claims that the substituted item meets the performance requirements with lesser construction (such as lesser heat exchange surface, etc.). Performance as delineated in schedules and in the specifications shall be interpreted as minimum performance. In many cases equipment is oversized to allow for pick-up loads which cannot be delineated under the minimum performance.

7. All equipment of one type such as drains, pumps, fixtures, etc. shall be the products of one Manufacturer.

8. Substituted equipment or optional equipment where permitted and approved, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether approved or not, shall be replaced at the Contractor's expense. Any modifications of related systems as a result of substitutions shall be made at the Contractor's expense.

9. Note that the approval of shop drawings, or other information submitted in accordance with the requirements hereinbefore specified, does not assure that the Engineer, Architect, or any other Owner's Representative, attests to the dimensional accuracy or dimensional suitability of the material or equipment involved or the ability of the material or equipment involved or the mechanical performance of equipment. Approval of Shop Drawings does not invalidate the plans and specifications if in conflict, unless a letter requesting such change is submitted and approved on the Engineer's letterhead.

10. Substitutions of equipment for that shown on the schedules or designated by model number in the specifications will not be considered if the item is not a regular cataloged item shown in the current catalog of the manufacturer.

11. Prohibition of Lead

    a. The presence and use of lead is strictly prohibited in potable water systems.

    b. Potable water shall not be subject to contact with lead in any form.

    c. The design and manufacture of all materials and equipment (piping, fittings, joints, connections, solders, fixtures, accessories, etc.) provided, shall not contain lead in any form.

    d. Contractor shall be responsible for all costs involved in testing and certifying that potable water systems, materials and equipment are lead free.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

    1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 ACCESS DOORS IN FINISHED CONSTRUCTION

A. Access doors as required for operation and maintenance of concealed equipment, valves, controls, etc. will be provided as part of the work of Division 08.

B. This Contractor is responsible for access door location, size and its accessibility to the valves, controls, equipment, etc. being served.

C. Coordinate and prepare a location, size, and function schedule of access doors required and deliver to a representative of the Contractor for Division 08.

D. Furnish and install distinctively colored buttons in finished ceiling.

E. Access doors shall be of ample size to perform proper maintenance on concealed equipment, valves, controls, etc. but shall not be less than a minimum of 16" x 16".

F. Construct doors and frames to comply with the requirements of the NFPA and Underwriters Laboratories Inc. for fire rating. Install UL label on each door in a non-exposed location unless otherwise required by the local authority having jurisdiction.

2.3 FOUNDATIONS

A. General

1. All equipment, piping, etc., mounted on/or suspended from approved foundations and supports, as specified, as shown on the drawings.

2. All concrete foundations and supports (and required reinforcing and forms) will be provided by the Contractor responsible for the work of Division 03. This trade shall furnish shop drawings showing adequate concrete reinforcing steel details and templates for all concrete foundations and supports, and all required hanger bolts and other appurtenances necessary for the proper installation of his equipment. Although another trade will complete all concrete work, all such work shall be shown in detail on the shop drawings, prepared by this trade, which drawings shall be submitted showing the complete details of all foundations including necessary concrete and steel work, etc.

B. Outdoor applications and all indoor applications in a harsh environment, comply with requirements in Division 09; Section titled “High Performance Coating.”

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Sections of this Division specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes, free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Sleeves are not required for core-drilled holes.

L. Permanent sleeves are not required for holes formed by removable PE sleeves.

M. Install sleeves for pipes passing through poured concrete and masonry walls, gypsum-board partitions, and poured concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1.4 inch (6.4 mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

    a. Steel or Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).

    b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.

    c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

        (i) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section #’s "Joint Sealants" for materials and installation.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1 inch (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1 inch (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Through-Penetration Firestop Systems" for materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

S. No installation shall be permitted which blocks or otherwise impedes access to any existing machine or system. Except as otherwise indicated, emergency switches and alarms shall be installed in conspicuous locations. All indicators, to include gauges, meters, and alarms shall be mounted in order to be easily visible by people in the area.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.3 PAINTING

A. Refer to Division 09 titled Finishes for painting requirements

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

C. Provide prime coat painting for the following if not provided with factory applied corrosion protection.

1. Miscellaneous steel and iron provided by Contractor responsible for the work of Division 22.

2. Hangers and supports iron provided by Contractor responsible for the work of Division 22.

3. Miscellaneous steel and iron provided by Contractor responsible for the work of Division 22 installed outdoors shall be provided with finished coats of exterior paint in accordance with requirements of Division 09 titled “Finishes” in addition to prime coat.

4. Plastic piping outdoors shall be field painted with two layers of water-based latex.

3.4 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inches (450 mm) centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 ERECTION OF WOOD AND METAL SUPPORTS AND ANCHORAGES

A. Comply with requirements in Division 05 "Metal." .

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

C. Refer to Division 22, Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment" for additional requirements.

D. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.

E. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between

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

G. Field welding: Comply with requirements AWS D1.1 titled "Structural Welding Code."

3.6 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 01; Section titled "Execution" covering "cutting and patching." In addition to the requirements of Division 01 of this Specification, the following requirements shall apply:

1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work.

2. Remove and replace defective Work.

3. Remove and replace Work not conforming to requirements of the Contract Documents.

4. Remove samples of installed Work as specified for testing.

5. Install equipment and materials in existing structures.

6. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

C. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.

D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

F. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

1. Refer to Division 01 Section titled “References” for definition of "experienced Installer."

G. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

1. Refer to Division 01 Section titled “References” for definition of "experienced Installer”.

3.7 DRIP PANS

A. Examine the drawings and in cooperation with the Electrical Trade and Food Service Trade confirm the final location of all electrical equipment to be installed in the vicinity of piping. Plan and arrange all overhead piping no closer than two feet from a vertical line to electric motors and controllers, switchboards, panelboards, or similar equipment. Piping is not permitted in Electric Equipment, Transformer, Switch Gear, Telephone Rooms. Except as required by the authority having jurisdiction to provide fire suppression.

B. Where the installation of piping does not comply with the requirements of foregoing paragraph, the piping shall be relocated.

C. Furnish gutters as follows:

1. Provide and erect a gutter of 16 ounce cold rolled copper or 18 gauge galvanized steel, under every pipe which is within 2'-0" from a vertical line to any motor, electrical controllers, switchboards, panel boards, or the like.

2. Each gutter shall be reinforced, rimmed, soldered and made watertight, properly suspended and carefully pitched to a convenient point for draining. Provide a 3/4" drain, with valve as directed, to nearest floor drain or slop sink, as approved.

In lieu of such separate gutters, a continuous protecting sheet of similar construction adequately supported and braced, properly rimmed, pitched and drained, may be provided over any such motor, and extending 2'-0" in all directions beyond the motor, over which such piping has to run.

D. Provide a leak detection system in each drip pan.

3.8 TESTS

A. Provide all designating signs for shutoff valves, control valves, alarms, and the like, as required by the agencies having jurisdiction.

B. Testing of Systems

1. Perform all required tests in the manner prescribed by and to the satisfaction of the local building department and local plumbing inspector, Owners Insurance Underwriters, and all authorities having jurisdiction. Owners and Architects representatives shall be present to inspect tests. Obtain all required certificates of approval and pay any fees or costs in conjunction therewith.

2. Provide and pay for all devices, materials, supplies, labor and power required in connection with all tests. All tests shall be made in the presence and to the satisfaction of the Architect and inspectors having jurisdiction.

3. Defects disclosed by the tests shall be repaired, or if required by the Architect, defective work shall be replaced with new work without extra charge to the Owner. Tests shall be repeated as directed, until all work is proven satisfactory.

4. This Contractor shall also be responsible for the work of other trades that may be damaged or disturbed by the tests, or the repair or replacement of his own work, and he shall, without extra charge to the Owner, restore to its original condition, work of the trades so damaged and disturbed, engaging the original Contractors to do the work of restoration.

3.9 PROTECTION AND CLEANING

A. Cleaning of Piping System (General)

1. During construction, properly cap, plug and cover all openings in pipe, lines and equipment nozzles so as to prevent the entrance of sand, dirt, and foreign matter. Each system of piping shall be flushed (for the purpose of removing grit, dirt, sand, and foreign matter from the piping), for as long a time as is required to thoroughly clean the systems.

B. Adjusting (General)

1. After the entire installation has been completed, make all required adjustments to balancing valves, air vents, automatic controls, circulators, flush valves, faucets, pressure reducing valves, etc., until all performance requirements are met. All water circulating systems shall be properly balanced.

C. All bearings of all equipment shall be oiled or greased as recommended by the manufacturer, after installation.

D. The alignment of each centrifugal pump shall be checked and each pump shall be properly aligned after the pumps are placed in service. Mechanical seals and shaft sleeves shall be replaced by this Contractor without charge in the event that unusual wear or faulty operation occurs during the guarantee period.

E. Cleaning (General)

1. Upon completion of the work, all fixtures, trimmings and equipment shall be thoroughly cleaned, polished and left in first class condition for final acceptance.

3.10 EQUIPMENT PROVIDED UNDER OTHER DIVISION OF THE WORK THAT REQUIRES PLUMBING

A. Certain equipment kitchen, laundry, will be supplied under other sections of the work. This Contractor shall provide as described below the requirements and all necessary services roughing and final connections as shown on the plans and as required.

B. Installation of the equipment shall be performed in the following manner.

1. Roughing: Provide all water, waste, vent piping and special laboratory services (acid waste and vent piping, gas, air vacuum, etc.) complete in accordance with detailed dimensioned drawings, to be provided by the equipment suppliers. This roughing shall be left ready for final connection to tables and equipment terminated at a point and height indicated by the Equipment Suppliers drawings.

2. Setting of Equipment: The Equipment Supplier will furnish and set in place and secure all equipment.

3. Final Connection: This trade shall make all final connections after the equipment has been set in place.

4. Trim: The Equipment Supplier will furnish all specialized appliances and trim such as faucets, tailpieces, strainers, service outlet bibbs, cocks, serrated hose connections and other related trim. This Trade shall coordinate and check with the Equipment Supplier and shall provide all valve, traps, stops, escutcheons, branch control valves, floor and funnel drains, nipples, fittings, tailpieces, pressure reducing valves, vacuum breakers, check valve, and other appurtenances which are not supplied by the Equipment Supplier and are necessary to the operating characteristics of the equipment being furnished. Also install all trim furnished with the equipment, as required, in accordance with the manufacturer's recommendations.

5. All exposed to view final connection piping, fittings, valves, etc., shall be chrome plated with finish matching equipment rim finishes. Submit finish samples to Architect for approval. Attention is hereby drawn to the Equipment Specifications being prepared under other sections of the work.

C. Review all Architectural drawings and equipment cuts for all equipment locations & services required at each piece of equipment.

3.11 EXCAVATION AND BACKFILL

A. All excavation and backfill will be done by General Contractor. The Plumbing Contractor shall be responsible for the coordination of trench routing, slope and elevation.

B. Instructions:

1. Trenches shall be excavated so that pipe can be laid to the alignment and depth indicated on the drawings, and shall be excavated only so far in advance of pipe laying as approved.

2. Width of trenches shall be held to a minimum consistent with the type of material encountered and the size of the pipe being laid, but the width at the top of the pipe shall not be more than 2'-0" plus outside diameter of pipe. Excavation for manholes and other accessories shall have 12" minimum and a 24" maximum clearance on all sides.

3. Before fill or backfilling commences, all trash, debris and other foreign material shall be removed from trenches to be backfilled by this Trade. Fill material shall be free from timber, rocks 3" or larger, organic material, frozen material, and other unsuitable material as determined by the Architect. Filling shall not be done in freezing weather, unless specifically approved. No filling shall be done when material already in place is frozen.

4. In filling around pipe, deposit backfill material in successive horizontal layers not exceeding 6" in thickness before compaction. Compact each layer thoroughly by means of approved mechanical tampers. Take special care to obtain compaction under pipe haunches. Deposit backfill adjacent to pipes on both sides to approximately same elevation at the same time. Continue this method of filling and compacting until backfill is at least 18" above top of pipe.

5. Backfilling for the remainder of pipe trenches to subgrades of paved or landscaped areas shall be done by mechanical tamping and rolling equipment, except that the use of such equipment is prohibited when said use may result in damage to pipelines or structures.

6. Backfill shall be moistened as necessary for proper compaction. Water settling of fill will not be permitted.

7. Complete backfilling of pipe trenches as soon as possible after the pipe is laid and tested.

8. Existing pavements, roadways, walkways, curbs and landscaped areas disturbed during the progress of the excavation and backfill work shall be restored to their original condition at no additional cost to the Owner.

9. Backfill shall be compacted to a minimum of 90% of modified AASHO maximum density as defined by ASTM D-1557. Any layer of fill, or portion thereof, which is not compacted to the required density shall be recompacted until the specified density is achieved, or the layer shall be removed.

3.12 APPLIANCES, TOILET ROOM ACCESSORIES AND TRIM

A. Handle and install all Plumbing connected appliances claimed under Plumber's jurisdiction from tailboard delivery, including hoisting and rigging to designated locations.

B. Handle and install all accessories and trim claimed under Plumber's jurisdiction.

C. Dispose of all appliance and accessories packing crates and debris off of the site.

3.13 ARCHITECTURAL COORDINATION AND SAMPLES

A. All devices and appurtenances which are to be installed in all finished areas must be coordinated with the Architect for final approval as it relates to location, finish, materials, color, texture, etc.

B. Submit samples of all materials requested by the Architect.

C. Samples shall be prepared and submitted with all postage and transportation costs paid by the Contractor submitting same. Label each sample with identifying numbers and titles.

D. Submit samples of:

1. All exposed to view finishes such as cleanout plates, access covers, drain grates and tops, fixture trim, fresh air inlet plates, gas vent caps, etc.

END OF SECTION 22 05 00

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SECTION 22 05 08 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes testing, adjusting, and balancing plumbing systems to produce design objectives, including but not limited to the following:

1. Balancing hot water circulation flow within distribution systems, including submains and/or branches.

2. Measuring electrical performance of plumbing equipment.

3. Setting quantitative performance of plumbing equipment.

4. Verifying that automatic control devices are functioning properly.

5. Reporting results of the activities and procedures specified in this Section.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Testing and adjusting requirements unique to particular systems and equipment are included in the Sections that specify those systems and equipment.

2. Field quality-control testing to verify that workmanship quality for system and equipment installation is specified in system and equipment Sections.

3. Division 22 Section 22 05 00 “Common Work Results for Plumbing”.

4. This Section is a part of each Division 22.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate at the terminal equipment, such as to adjust balancing valves.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

C. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

D. Report Forms: Test data sheets for recording test data in logical order.

E. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

F. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

G. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

H. System Effect Factory: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

I. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

J. Test: A procedure to determine quantitative performance of a system or equipment.

K. Testing, Adjusting, and Balancing: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

1.4 SUBMITTALS

A. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.

B. Contract Documents Examination Report: Within 45 days from the Contractor's Notice to Proceed, submit 2 copies of the Contract Documents review report as specified in Part 3 of this Section.

C. Strategies and Procedures Plan: Within 60 days from the Contractor's Notice to Proceed, submit 2 copies of the testing, adjusting, and balancing strategies and step-by-step procedures as specified in Part 3 "Preparation" Article below. Include a complete set of report forms intended for use on this Project.

D. 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.

E. Sample Report Forms: Submit 2 sets of sample testing, adjusting, and balancing report forms.

F. Warranty: Submit 2 copies of special warranty specified in the "Warranty" Article below.

1.5 QUALITY ASSURANCE

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, plumbing controls Installer, and other support personnel. Provide 7 days' advance notice of scheduled meeting time and location.

1.6 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, Plumbing controls installers, and other mechanics to operate plumbing systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.

1.7 WARRANTY

A. General Warranty: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

(Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.

2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings 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.

B. Examine approved submittal data of plumbing systems and equipment.

C. Examine project record documents described in Division 01 Section "Project Record Documents."

D. Examine Architect's and Engineer's design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about plumbing system and equipment controls.

E. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

F. Examine system and equipment test reports.

G. Examine plumbing system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

H. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

I. Examine strainers for clean screens and proper perforations.

J. Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows (if required).

K. Examine open-piping-system pumps to ensure absence of entrained air in the suction piping.

L. Examine equipment for installation and for properly operating safety interlocks and controls.

M. Examine automatic temperature system components to verify the following:

1. Valves, and other controlled devices operate by the intended controller.

2. Valves are in the position indicated by the controller.

3. Integrity of valves for free and full operation and for tightness of fully closed and fully open positions.

4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected (if required).

5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.

6. Sensors are located to sense only the intended conditions.

7. Sequence of operation for control modes is according to the Contract Documents.

8. 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.

9. Interlocked systems are operating.

N. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.2 PREPARATION

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.

2. Water systems are filled, clean, and free of air.

3. Equipment access doors are securely closed.

4. Isolating and balancing valves are open and control valves are operational.

3.3 GENERAL TESTING AND BALANCING PROCEDURES

A. Mark equipment settings with paint or other suitable, permanent identification material, including valve indicators, and similar controls and devices, to show final settings.

3.4 FUNDAMENTAL PROCEDURES FOR HOT WATER CIRCULATION SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.

2. Check expansion tank liquid level.

3. Check makeup-water-station pressure gage for adequate pressure for highest vent.

4. Check flow-control valves for specified sequence of operation and set at design flow.

5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type, unless several terminal valves are kept open.

6. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

7. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.5 HOT WATER CIRCULATION SYSTEMS' BALANCING PROCEDURES

A. Determine water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Verify with the pump manufacturer that this will not damage pump. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on the manufacturer's pump curve at zero flow and confirm that the pump has the intended impeller size.

2. Check system resistance. With all valves open, read pressure differential across the pump and mark the pump manufacturer's head-capacity curve. Adjust pump discharge valve until design water flow is achieved.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on the pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

4. Report flow rates that are not within plus or minus 5 percent of design.

3.6 WATER HEATERS

A. Measure entering- and leaving-water temperatures and water flow.

3.7 TEMPERATURE-CONTROL VERIFICATION (MIXING VALVES)

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Verify free travel and proper operation of control devices such as valve operators.

F. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water-flow measurements. Note the speed of response to input changes.

G. Confirm interaction of electrically operated switch transducers.

H. Confirm interaction of interlock and lockout systems.

I. Verify main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine if the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.8 TOLERANCES

A. Set plumbing system water flow rates within the following tolerances:

1. Heating-Water Flow Rate: 0 to minus 10 percent.

3.9 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article above, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to plumbing systems and general construction to allow access for performance measuring and balancing devices.

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.

END OF SECTION 22 05 08

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SECTION 22 05 16 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Flexible-hose packless expansion joints.

2. Metal-bellows packless expansion joints.

3. Rubber packless expansion joints.

4. Grooved-joint expansion joints.

5. Pipe loops and swing connections.

6. Alignment guides and anchors.

1.3 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.4 GENERAL DESIGN REQUIREMENTS

A. Professional Engineer

1. As part of the work, the contractor shall engage the services of a professional engineer with experience in the field of piping support and expansion and contraction of piping systems.

B. General

1. The plumbing system, including all piping, risers, horizontal runs and parts thereof shall be designed to take into account the effects of thermal expansion and contraction and building movement (shrinkage, expansion joints, etc.)

2. It shall be understood that the requirements of this section are complimentary to requirements delineated elsewhere for the support and fastening of equipment, piping, etc. Nothing on the drawings and specifications shall be interpreted as reason to waive the requirements of this section.

1.5 ACTION SUBMITTALS

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

B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.

2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.

3. Alignment Guide Details: Detail field assembly and attachment to building structure.

4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of expansion joint, from manufacturer.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 PACKLESS EXPANSION JOINTS

A. Flexible-Hose Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Flex Pression Ltd.

b. Metraflex, Inc.

c. Flexicraft.

d. Omega.

3. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.

4. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.

5. Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with solder-joint end connections.

   a. Bronze hoses and single-braid bronze sheaths with 300 psig at 70 deg F (2065 kPa at 21 deg C) rating.

   b. Bronze hoses and double-braid bronze sheaths with 500 psig at 70 deg F (3445 kPa at 21 deg C) rating.

6. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with solder-joint end connections.

   a. Bronze hoses and single-braid, bronze sheaths with 100 psig at 70 deg F (965 kPa at 21 deg C) rating.

   b. Bronze hoses and double-braid, bronze sheaths with 225 psig at 70 deg F (1550 kPa at 21 deg C) rating.

7. Expansion Joints for Steel Piping NPS 2 (DN 50) and Smaller: Stainless-steel fittings with threaded end connections.

   a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C).

   b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F (4830 kPa at 21 deg C.

8. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Stainless-steel fittings with flanged end connections.

   a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 165 psig at 70 deg F (1138 kPa at 21 deg C).

   b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 250 psig at 70 deg F (1724 kPa at 21 deg C).

9. Expansion Joints for Steel Piping NPS 8 to NPS 12 (DN 200 to DN 300): Stainless-steel fittings with flanged end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F (860 kPa at 21 deg C).

    b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F (1130 kPa at 21 deg C).

B. Metal-Bellows Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

    a. Flexicraft Industries.

    b. Flex Pression Ltd.

    c. Metraflex, Inc.

3. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

4. Type: Circular, corrugated bellows with external tie rods.

5. Minimum Pressure Rating: 150 psig (1035 kPa) unless otherwise indicated.

6. Configuration: Single joint and double joint with base class(es) unless otherwise indicated.

    a. End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: Solder joint.

    b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Solder joint.

    c. End Connections for Steel Piping: NPS 2 (DN 50) and Smaller: Threaded.

    d. End Connections for Steel Piping: NPS 2½ (DN 65) and Larger: Flanged.

C. Rubber Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   a. Flexicraft Industries.

   b. Mason Industries, Inc.; Mercer Rubber Co.

   c. Metraflex, Inc.

   d. Red Valve.

3. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

4. Material: Fabric-reinforced rubber complying with FSA-NMEJ-703.

5. Arch Type: Single arch with external control rods.

6. Spherical Type: Single spheres with external control rods.

7. Minimum Pressure Rating for NPS 1-1/2 to NPS 4 (DN 40 to DN 100): 150 psig (1035 kPa) at 220 deg F (104 deg C).

8. Minimum Pressure Rating for NPS 5 and NPS 6 (DN 125 and DN 150): 140 psig (966 kPa) at 200 deg F (93 deg C).

9. Material for Fluids Containing Acids, Alkalies, or Chemicals: EPDM.

10. Material for Fluids Containing Gas, Hydrocarbons, or Oil: Buna-N.

11. Material for Water: BR.

12. End Connections: Full-faced, integral steel flanges with steel retaining rings.

2.2 GROOVED-JOINT EXPANSION JOINTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   1. Anvil International, Inc.

   2. Shurjoint Piping Products.

   3. Victaulic Company.

C. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.

D. Standard: AWWA C606, for grooved joints.

E. Nipples: Galvanized, ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.

F. Couplings: Five Seven 10 12, flexible type for steel-pipe dimensions. Include ferrous housing sections, EPDM gasket suitable for cold and hot water, and bolts and nuts.

2.3 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Flexicraft Industries.

b. Mason Industries, Inc.

c. Metraflex, Inc.

3. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.

2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.

3. Washers: ASTM F 844, steel, plain, flat washers.

4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

a. Stud: Threaded, zinc-coated carbon steel.

b. Expansion Plug: Zinc-coated steel.

c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.

b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.

c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

C. Install rubber packless expansion joints according to FSA-NMEJ-702.

D. Install grooved-joint expansion joints to grooved-end steel piping.

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least four pipe fittings including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.

D. Connect mains and branch connections to terminal units with at least five pipe fittings including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe and secure guides to building structure.

D. Install anchors at locations indicated on the drawings to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Black-Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

2. Anchor Attachment to Galvanized-Steel Pipe: Attach with pipe hangers. Use MSS SP-69, Type 42, riser clamp welded to anchor.

3. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.

2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 22 05 16

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SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.

2. Stack-sleeve fittings.

3. Sleeve-seal systems.

4. Sleeve-seal fittings.

5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

2. Metraflex.
3. Mifab.

C. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Advance Products & Systems, Inc.

2. CALPICO, Inc.

3. Metraflex Company (The).

4. Pipeline Seal and Insulator, Inc.

5. Link-Seal.

C. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

2. Pressure Plates: Carbon steel Plastic Stainless steel.

3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant or stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Link seal.

2. Flexicraft.

3. Metraflex.

4. Presealed Systems.

C. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.

2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.

2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 07 92 00 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

F. Sleeves are not required for core-drilled holes.

G. Permanent sleeves are not required for holes formed by removable PE sleeves.

H. Install sleeves for pipes passing through poured concrete and masonry walls, gypsum-board partitions, and poured concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel or Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).

b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.

c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

(i) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section #'s "Joint Sealants" for materials and installation.

I. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

J. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.

2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 62 00 "Sheet Metal Flashing and Trim."

3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.

4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves Galvanized-steel wall sleeves Galvanized-steel-pipe sleeves or Sleeve-seal fittings.

b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves Galvanized-steel wall sleeves or Galvanized-steel-pipe sleeves.

2. Exterior Concrete Walls below Grade:

a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system Galvanized-steel wall sleeves with sleeve-seal system Galvanized-steel-pipe sleeves with sleeve-seal system or Sleeve-seal fittings.

(i) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.

(i) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system Galvanized-steel wall sleeves with sleeve-seal system Galvanized-steel-pipe sleeves with sleeve-seal system or Sleeve-seal fittings.

(i) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system Galvanized-steel wall sleeves with sleeve-seal system Galvanized-steel-pipe sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves.

(i) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves PVC-pipe sleeves Stack-sleeve fittings or Sleeve-seal fittings.

b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves or Stack-sleeve fittings.

5. Interior Partitions:

a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.

b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 22 05 17

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SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.

2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.

c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.

e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.

f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.

g. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated rough-brass finish.

2. Escutcheons for Existing Piping:

a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.

b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.

c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.

d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.

e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated rough-brass finish.

f. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated rough-brass finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.

E. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.

c. Insulated Piping: One-piece, stamped-steel type with spring clips.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.

f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.

g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.

h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.

i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.

j. Bare Piping in Equipment Rooms: One-piece, cast-brass type.

k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.

l. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 22 05 18

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SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Filled-system thermometers.
3. Liquid-in-glass thermometers.
4. Dial-type pressure gages.
5. Gage attachments.
6. Test plugs.
7. Test-plug kits.
8. Sight flow indicators.

B. Related Sections:

1. Section 22 11 16 "Domestic Water Piping" for water meters inside the building.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Ashcroft Inc.
2. Ernst Flow Industries.
3. Marsh Bellofram.
4. Miljoco Corporation.
5. Nanmac Corporation.
6. Noshok.
7. Palmer Wahl Instrumentation Group.
8. REOTEMP Instrument Corporation.
9. Tel-Tru Manufacturing Company.
10. Trerice, H. O. Co.
11. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
12. Weiss Instruments, Inc.
13. WIKA Instrument Corporation - USA.
14. Winters Instruments - U.S.

C. Standard: ASME B40.200.

D. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch (127-mm) nominal diameter suitable for potable water.

E. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F (deg C) deg F and deg C.

F. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

G. Connector Size: 1/2 inch (13 mm), with ASME B1.1 screw threads.

H. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.

I. Window: Plain glass or plastic.

J. Ring: Stainless steel.

K. Element: Bimetal coil.

L. Pointer: Dark-colored metal.

M. Accuracy: Plus or minus 1 to 1.5 percent of scale range.

2.2 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   a. Ashcroft Inc.
   b. Marsh Bellofram.
   c. Miljoco Corporation.
   d. Palmer Wahl Instrumentation Group.
   e. REOTEMP Instrument Corporation.
   f. Trerice, H. O. Co.
   g. Weiss Instruments, Inc.

3. Standard: ASME B40.200.

4. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch (114-mm) 5-inch (127-mm) 6-inch (152-mm) nominal diameter.

5. Element: Bourdon tube or other type of pressure element.

6. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.

7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) deg F and deg C.

8. Pointer: Dark-colored metal.

9. Window: Glass or plastic.

10. Ring: Metal or Stainless steel.

11. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device rigid, back and rigid, bottom; with ASME B1.1 screw threads.

12. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

13. Accuracy: Plus or minus 1 percent of scale range.

B. Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   a. Ashcroft Inc.
   b. Miljoco Corporation.
   c. REOTEMP Instrument Corporation.

3. Standard: ASME B40.200.

4. Case: Sealed type, plastic; 4-1/2-inch (114-mm) 5-inch (127-mm) 6-inch (152-mm) nominal diameter.

5. Element: Bourdon tube or other type of pressure element.

6. Movement: Mechanical, with link to pressure element and connection to pointer.

7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) deg F and deg C.

8. Pointer: Dark-colored metal.

9. Window: Glass or plastic.

10. Ring: Metal or plastic.

11. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device rigid, back and rigid, bottom; with ASME B1.1 screw threads.

12. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

13. Accuracy: Plus or minus 1 percent of scale range.

C. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

    a. AMETEK, Inc.; U.S. Gauge.
    b. Ashcroft Inc.
    c. Marsh Bellofram.
    d. Miljoco Corporation.
    e. Palmer Wahl Instrumentation Group.
    f. REOTEMP Instrument Corporation.
    g. Trerice, H. O. Co.
    h. Weiss Instruments, Inc.
    i. WIKA Instrument Corporation - USA.

3. Standard: ASME B40.200.

4. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch (114-mm) 6-inch (152-mm) nominal diameter with back front flange and holes for panel mounting.

5. Element: Bourdon tube or other type of pressure element.

6. Movement: Mechanical, with link to pressure element and connection to pointer.

7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) deg F and deg C.

8. Pointer: Dark-colored metal.

9. Window: Glass or plastic.

10. Ring: Metal Stainless steel.

11. Connector Type(s): Union joint, back bottom; with ASME B1.1 screw threads.

12. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

13. Accuracy: Plus or minus 1 percent of scale range.

D. Remote-Mounted, Plastic-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

a. AMETEK, Inc.; U.S. Gauge.
b. Ashcroft Inc.
c. Miljoco Corporation.
d. REOTEMP Instrument Corporation.
e. Trerice, H. O. Co.

3. Standard: ASME B40.200.

4. Case: Sealed type, plastic; 4-1/2-inch (114-mm) 6-inch (152-mm) nominal diameter with back front flange and holes for panel mounting.

5. Element: Bourdon tube or other type of pressure element.

6. Movement: Mechanical, with link to pressure element and connection to pointer.

7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) deg F and deg C.

8. Pointer: Dark-colored metal.

9. Window: Glass or plastic.

10. Ring: Metal or plastic.

11. Connector Type(s): Union joint, threaded, back bottom; with ASME B1.1 screw threads.

12. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

a. Design for Thermowell Installation: Bare stem.

13. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. Trerice, H. O. Co.

3. Standard: ASME B40.200.

4. Case: Cast aluminum; 6-inch (152-mm) nominal size.

5. Case Form: Back angle or Straight unless otherwise indicated.

6. Tube: Glass with magnifying lens and blue or red organic liquid.

7. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) deg F and deg C.

8. Window: Glass or plastic.

9. Stem: Aluminum or brass and of length to suit installation.

   a. Design for Thermowell Installation: Bare stem.

10. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.

11. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   a. Flo Fab Inc.
   b. Miljoco Corporation.
   c. Tel-Tru Manufacturing Company.
   d. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   e. Weiss Instruments, Inc.
   f. WIKA Instrument Corporation - USA.

3. Standard: ASME B40.200.

4. Case: Plastic; 6-inch (152-mm) nominal size.

5. Case Form: Back angle or Straight unless otherwise indicated.

6. Tube: Glass with magnifying lens and blue or red organic liquid.

7. Tube Background: Nonreflective with permanently etched scale markings graduated in deg F (deg C) deg F and deg C.

8. Window: Glass or plastic.

9. Stem: Aluminum or brass and of length to suit installation.

   a. Design for Thermowell Installation: Bare stem.

10. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.

11. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

C. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   a. Flo Fab Inc.
   b. Miljoco Corporation.
   c. Palmer Wahl Instrumentation Group.
   d. Tel-Tru Manufacturing Company.
   e. Trerice, H. O. Co.
   f. Weiss Instruments, Inc.
   g. Winters Instruments - U.S.

3. Standard: ASME B40.200.

4. Case: Cast aluminum; 7-inch (178-mm) 9-inch (229-mm) nominal size unless otherwise indicated.

5. Case Form: Adjustable angle Back angle Straight unless otherwise indicated.

6. Tube: Glass with magnifying lens and blue or red organic liquid.

7. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) deg F and deg C.

8. Window: Glass or plastic.

9. Stem: Aluminum and of length to suit installation.

   a. Design for Thermowell Installation: Bare stem.

10. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.

11. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

D. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   a. Ernst Flow Industries.
   b. Marsh Bellofram.
   c. Miljoco Corporation.
   d. Palmer Wahl Instrumentation Group.
   e. REOTEMP Instrument Corporation.
   f. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   g. Weiss Instruments, Inc.
   h. WIKA Instrument Corporation - USA.

3. Standard: ASME B40.200.

4. Case: Plastic; 7-inch (178-mm) 9-inch (229-mm) nominal size unless otherwise indicated.

5. Case Form: Adjustable angle Back angle or Straight unless otherwise indicated.

6. Tube: Glass with magnifying lens and blue or red organic liquid.

7. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C) deg F and deg C.

8. Window: Glass or plastic.

9. Stem: Aluminum, brass, or stainless steel and of length to suit installation.

   a. Design for Thermowell Installation: Bare stem.

10. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.

11. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.4 LIGHT-ACTIVATED THERMOMETERS

A. Direct-Mounted, Light-Activated Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

    a. Flo Fab Inc.
    b. REOTEMP Instrument Corporation.
    c. Trerice, H. O. Co.
    d. Weiss Instruments, Inc.
    e. WIKA Instrument Corporation - USA.
    f. Winters Instruments - U.S.

3. Case: Plastic Metal; 7-inch (178-mm) 9-inch (229-mm) nominal size unless otherwise indicated.

4. Scale(s): Deg F (Deg C) Deg F and deg C.

5. Case Form: Adjustable angle.

6. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.

7. Stem: Aluminum and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

8. Display: Digital.

9. Accuracy: Plus or minus 2 deg F (1 deg C).

B. Remote-Mounted, Light-Activated Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Miljoco Corporation.
    b. Weiss Instruments, Inc.
    c. Winters Instruments - U.S.

3. Case: Plastic, for wall mounting.

4. Scale(s): Deg F (Deg C) Deg F and deg C.

5. Sensor: Bulb and thermister wire.

    a. Design for Thermowell Installation: Bare stem.

6. Display: Digital.

7. Accuracy: Plus or minus 2 deg F (1 deg C).

2.5 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

a. AMETEK, Inc.; U.S. Gauge.
b. Ashcroft Inc.
c. Ernst Flow Industries.
d. Flo Fab Inc.
e. Marsh Bellofram.
f. Miljoco Corporation.
g. Noshok.
h. Palmer Wahl Instrumentation Group.
i. REOTEMP Instrument Corporation.
j. Tel-Tru Manufacturing Company.
k. Trerice, H. O. Co.
l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
m. Weiss Instruments, Inc.
n. WIKA Instrument Corporation - USA.
o. Winters Instruments - U.S.

3. Standard: ASME B40.100.

4. Case: Liquid-filled Sealed Solid-front, pressure relief type(s); cast aluminum or drawn steel ; 4-1/2-inch (114-mm) 6-inch (152-mm) nominal diameter.

5. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

6. Pressure Connection: Brass, with NPS 1/4 (DN 8) NPS 1/4 or NPS 1/2 (DN 8 or DN 15) NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.

7. Movement: Mechanical, with link to pressure element and connection to pointer.

8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) psi and kPa.

9. Pointer: Dark-colored metal.

10. Window: Glass or plastic .

11. Ring: Metal Brass or Stainless steel.

12. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

B. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   a. AMETEK, Inc.; U.S. Gauge.
   b. Ashcroft Inc.
   c. Flo Fab Inc.
   d. Marsh Bellofram.
   e. Miljoco Corporation.
   f. Noshok.
   g. Palmer Wahl Instrumentation Group.
   h. REOTEMP Instrument Corporation.
   i. Tel-Tru Manufacturing Company.
   j. Trerice, H. O. Co.
   k. Weiss Instruments, Inc.
   l. WIKA Instrument Corporation - USA.
   m. Winters Instruments - U.S.

3. Standard: ASME B40.100.

4. Case: Sealed type; plastic ; 4-1/2-inch (114-mm) 6-inch (152-mm) nominal diameter.

5. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

6. Pressure Connection: Brass, with NPS 1/4 (DN 8) NPS 1/4 or NPS 1/2 (DN 8 or DN 15) NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.

7. Movement: Mechanical, with link to pressure element and connection to pointer.

8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) psi and kPa.

9. Pointer: Dark-colored metal.

10. Window: Glass or plastic .

11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

C. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   a. AMETEK, Inc.; U.S. Gauge.
   b. Ashcroft Inc.
   c. Ernst Flow Industries.
   d. Flo Fab Inc.
   e. Marsh Bellofram.
   f. Miljoco Corporation.
   g. Noshok.
   h. Palmer Wahl Instrumentation Group.
   i. REOTEMP Instrument Corporation.
   j. Tel-Tru Manufacturing Company.
   k. Trerice, H. O. Co.
   l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   m. Weiss Instruments, Inc.
   n. WIKA Instrument Corporation - USA.
   o. Winters Instruments - U.S.

3. Standard: ASME B40.100.

4. Case: Liquid-filled Sealed type; cast aluminum or drawn steel metal ; 4-1/2-inch (114-mm) 6-inch (152-mm) nominal diameter with back front flange and holes for panel mounting.

5. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

6. Pressure Connection: Brass, with NPS 1/4 (DN 8) NPS 1/4 or NPS 1/2 (DN 8 or DN 15) NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.

7. Movement: Mechanical, with link to pressure element and connection to pointer.

8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) psi and kPa.

9. Pointer: Dark-colored metal.

10. Window: Glass or plastic .

11. Ring: Metal or Stainless steel .

12. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

D. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

   a. AMETEK, Inc.; U.S. Gauge.
   b. Ashcroft Inc.
   c. Miljoco Corporation.
   d. Noshok.
   e. Palmer Wahl Instrumentation Group.
   f. REOTEMP Instrument Corporation.
   g. Tel-Tru Manufacturing Company.
   h. Trerice, H. O. Co.
   i. Weiss Instruments, Inc.
   j. WIKA Instrument Corporation - USA.
   k. Winters Instruments - U.S.

3. Standard: ASME B40.100.

4. Case: Sealed type; plastic ; 4-1/2-inch (114-mm) 6-inch (152-mm) nominal diameter with back front flange and holes for panel mounting.

5. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

6. Pressure Connection: Brass, with NPS 1/4 (DN 8) NPS 1/4 or NPS 1/2 (DN 8 or DN 15) NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.

7. Movement: Mechanical, with link to pressure element and connection to pointer.

8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa) psi and kPa.

9. Pointer: Dark-colored metal.

10. Window: Glass or plastic .

11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.6 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8) NPS 1/4 or NPS 1/2 (DN 8 or DN 15) NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and piston porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball Brass or stainless-steel needle, with NPS 1/4 (DN 8) NPS 1/4 or NPS 1/2 (DN 8 or DN 15) NPS 1/2 (DN 15), ASME B1.20.1 pipe threads.

2.7 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Flow Design, Inc.
2. Miljoco Corporation.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Trerice, H. O. Co.
7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
8. Weiss Instruments, Inc.

C. Description: Test-station fitting made for insertion into piping tee fitting.

D. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

E. Thread Size: NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe thread.

F. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).

G. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.8 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product product by one of the following:

1. Flow Design, Inc.
2. Miljoco Corporation.
3. National Meter, Inc.
4. Peterson Equipment Co., Inc.
5. Sisco Manufacturing Company, Inc.
6. Trerice, H. O. Co.
7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
8. Weiss Instruments, Inc.

C. Furnish one test-plug kit(s) containing one two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

D. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F (minus 4 to plus 52 deg C) .

E. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F (minus 18 to plus 104 deg C) .

F. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).

G. Carrying Case: Metal or plastic, with formed instrument padding.

2.9 SIGHT FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Archon Industries, Inc.
2. Dwyer Instruments, Inc.
3. Emerson Process Management; Brooks Instrument.
4. Ernst Co., John C., Inc.
5. Ernst Flow Industries.
6. KOBOLD Instruments, Inc. - USA; KOBOLD Messring GmbH.
7. OPW Engineered Systems; a Dover company.
8. Penberthy; A Brand of Tyco Valves & Controls - Prophetstown.

C. Description: Piping inline-installation device for visual verification of flow.

D. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

E. Minimum Pressure Rating: 125 psig (860 kPa) 150 psig (1034 kPa).

F. Minimum Temperature Rating: 200 deg F (93 deg C).

G. End Connections for NPS 2 (DN 50) and Smaller: Threaded.

H. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches (51 mm) into fluid one-third of pipe diameter to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids.

J. Install test plugs in piping tees.

K. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.

L. Install pressure gages in the following locations:

1. Building water service entrance into building.

2. Inlet and outlet of each pressure-reducing valve.

3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:

1. Direct Remote-mounted, metal plastic-case, vapor-actuated type.

2. Compact Industrial-style, liquid-in-glass type.

3. Direct-mounted, light-activated type.

4. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE AND LOCATIONS

THERMOMETER LOCATION	TEMPERATURE RANGE
Hot water outlet of water heaters	30° to 240°F (0 to plus 115 deg C).
Cold water service into the building	0°to 100°F (minus 20 to plus 50 deg C).
Cold water inlet to water heaters	0° to 100°F (minus 20 to plus 50 deg C).
In hot water circulation line adjacent to and upstream of circulating pump	30° to 180°F (0 to plus 82 deg C).

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be one of the following:

1. Liquid-filled Sealed Open-front, pressure-relief Solid-front, pressure-relief, direct remote-mounted, metal case.

2. Sealed, direct remote-mounted, plastic case.

3. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:

1. Liquid-filled Sealed Open-front, pressure-relief Solid-front, pressure-relief direct remote-mounted, metal case.

2. Sealed direct remote-mounted, plastic case.

3. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.

C. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:

1. Liquid-filled Sealed Open-front, pressure-relief Solid-front, pressure-relief direct remote-mounted, metal case.

2. Sealed direct remote-mounted, plastic case.

3. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE AND LOCATION

Gauge Location	Pressure Range
At each water service point of entry in building.	0-150 p.s.i. (0 to 1034 kPa)
Each pump suction	0-150 p.s.i. (0 to 1034 kPa)
Each pump discharge	0-250 p.s.i. or as required. (0 to 1725 kPa)
Cold supply and hot water supply for water heaters	0-150 p.s.i. (0 to 1034 kPa)
Inlet & outlet of master pressure reducing valves.	0-250 p.s.i. or as required. (0 to 1725 kPa)

END OF SECTION 22 05 19

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SECTION 22 05 23 - VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. The valve schedule included in the contract drawings indicates the valve type to be used for the services indicated. Similar valves as made by approved manufacturers may be submitted for approval.

B. Section Includes:

1. Bronze ball valves.
2. Steel ball valves.
3. Iron ball valves.
4. Iron, single-flange butterfly valves.
5. Stainless steel butterfly valves
6. Bronze lift check valves.
7. Bronze swing check valves.
8. Iron swing check valves.
9. Iron, center-guided check valves.
10. Bronze gate valves.
11. Iron gate valves.
12. Chainwheels.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer rubber.

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

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve. Include manufacturer's submittals to include materials of construction, standards compliance, valve design, pressure and temperature ratings, end connections and dimensions. Include valve schedule indicating each valve and its application. Indicate all required options.

1. Certification that products comply with NSF 61 Annex G and NSF 372 where applicable.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, and soldered ends.

3. Set ball valves open to minimize exposure of functional surfaces.

4. Set butterfly valves closed or slightly open.

5. Set check valves in either closed or open position.

6. Set gate valves closed to prevent rattling.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.

2. ASME B16.1 for flanges on iron valves.

3. ASME B16.5 for flanges on steel valves.

4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

5. ASME B16.18 for solder-joint connections.

6. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

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

H. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 4 (DN 100) and larger.

2. Handlever: For quarter-turn valves smaller than NPS 4 (DN 100).

3. Chainwheel: Device for attachment to gear, handlever, or stem; of size and with chain for mounting height, according to "Valve Installation" Article.

I. Valves in Insulated Piping:

1. Include 2 inch (50 mm) stem extensions.

2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.

3. Memory stops that are fully adjustable after insulation is applied.

4. RS Valves in Insulated Piping: With 2 inch (50 mm) stem extensions.

2.2 BRONZE BALL VALVES

A. Two-Piece, Bronze Ball Valves with Full Port, and Bronze or Brass Trim:

1. Manufacturers:

a. Conbraco Industries, Apollo Valves

b. Milwaukee Valve Co.

c. Nibco, Inc.

B. Description:

1. Standard: MSS SP-110.

2. CWP Rating: 600 psig (4140 kPa).

3. Body Design: Two piece.

4. Body Material: Bronze.

5. Ends: Threaded or soldered.

6. Seats: PTFE.

7. Stem: Bronze or brass.

8. Ball: Chrome-plated brass.

9. Port: Full only. Standard port not permitted.

C. Three-Piece, Bronze Ball Valves with Full Port and Bronze or Brass Trim:

1. Manufacturers:

a. Conbraco Industries, Apollo Valves

b. Milwaukee Valve Co.

c. Nibco, Inc.

2. Description:

a. Standard: MSS SP-110.

b. CWP Rating: 600 psig (4140 kPa).

c. Body Design: Three piece.

d. Body Material: Bronze.

e. Ends: Threaded or soldered.

f. Seats: PTFE.

g. Stem: Bronze or brass.

h. Ball: Chrome-plated brass.

i. Port: Full only. Standard port not permitted.

D. Two-Piece, Safety-Exhaust, Bronze Ball Valves:

1. Manufacturers:

a. Milwaukee Valve Co.

b. Nibco, Inc.

2. Description:

a. Standard: MSS SP-110.

b. CWP Rating: 600 psig (4140 kPa).

c. Body Design: Two piece.

d. Body Material: Bronze, ASTM B 584, Alloy C844.

e. Ends: Threaded.

f. Seats: PTFE.

g. Stem: Bronze.

h. Ball: Chrome-plated brass, with exhaust vent opening for pneumatic applications.

i. Port: Full.

2.3 STEEL BALL VALVES

A. Class 150, Steel Ball Valves with Full Port:

1. Manufacturers:

a. Conbraco Industries, Apollo Valves

b. Milwaukee Valve Co.

c. Nibco, Inc.

2. Description:

a. Standard: MSS SP-72.

b. CWP Rating: 285 psig (1964 kPa).

c. Body Design: Split body.

d. Body Material: Carbon steel, ASTM A 216, Type WCB.

e. Ends: Flanged or threaded.

f. Seats: PTFE.

g. Stem: Stainless steel.

h. Ball: Stainless steel, vented.

i. Port: Full.

2.4 IRON BALL VALVES

A. Class 125, Iron Ball Valves:

1. Manufacturers:

a. Conbraco Industries, Apollo Valves

2. Description:

a. Standard: MSS SP-72.

b. CWP Rating: 200 psig (1380 kPa).

c. Body Design: Split body.

d. Body Material: ASTM A 126, gray iron.

e. Ends: Flanged.

f. Seats: PTFE.

g. Stem: Stainless steel.

h. Ball: Stainless steel.

i. Port: Full.

2.5 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:

1. Manufacturers:

a. Conbraco Industries, Apollo Valves

b. Milwaukee Valve Co.

c. Nibco, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.

b. CWP Rating: 250 psig (1725 kPa).

c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.

d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.

e. Seat: EPDM.

f. Stem: One- or two-piece stainless steel.

g. Disc: Aluminum bronze.

2.6 DUCTILE-IRON, GROOVED-END BUTTERFLY VALVES

A. 300 CWP, Iron, Grooved-End Butterfly Valves:

1. Manufacturers:

a. Nibco, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.

b. CWP Rating, NPS 8 (DN 200) and Smaller: 300 psig (2070 kPa).

c. Body Material: Coated, ductile iron.

d. Stem: Two-piece stainless steel.

e. Disc: Coated, ductile iron.

f. Seal: EPDM.

2.7 STAINLESS STEEL BUTTERFLY VALVES

A. Stainless steel, High-Performance Butterfly Valve with Stainless Steel Disc

1. Manufacturers:

a. Conbraco Industries, Apollo Valves

2. Description:

a. Standard: MSS SP-68

b. Pressure Class: 150 psig 300psig

c. Body Design: Lug type; suitable for bi-directional dead-end service at rated pressure without use of downstream flange.

d. Body Material: ASTM A351 CG8M, cast stainless steel

e. Seat: TFM 1700

f. Stem: 17-4 PH

g. Disc: ASTM A351 CF8M cast stainless steel

2.8 BRONZE LIFT CHECK VALVES

A. Class 250, Lift Check Valves with Nonmetallic Disc:

1. Manufacturers:

a. Milwaukee Valve Co.

b. Nibco, Inc.

2. Description:

a. Standard: MSS SP-80, Type 2.

b. WOG Rating: 250 psig (1725 kPa).

c. Body Design: Vertical flow.

d. Body Material: ASTM B 61 or ASTM B 62, bronze.

e. Ends: Threaded or threaded.

f. Disc: NBR, PTFE.

2.9 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers:

a. Conbraco Industries, Apollo Valves

b. Milwaukee Valve Co.

c. Nibco, Inc.

2. Description:

a. Standard: MSS SP-80, Type 4.

b. CWP Rating: 200 psig (1380 kPa).

c. Body Design: Horizontal flow.

d. Body Material: ASTM B 62, bronze.

e. Ends: Threaded or Soldered.

f. Disc: Bronze.

2.10 IRON SWING CHECK VALVES

A. Class 125 250, Iron Swing Check Valves with Metal Seats:

1. Manufacturers:

a. Conbraco Industries, Apollo Valves

b. Nibco, Inc.

2. Description:

a. Standard: MSS SP-71, Type I. 125 250

b. CWP Rating: 200 psig (1380 kPa) 500 psig (3450 kPa).

c. Body Design: Clear or full waterway.

d. Body Material: ASTM A 126, gray iron with bolted bonnet.

e. Ends: Flanged.

f. Trim: Bronze.

g. Gasket: Asbestos free.

2.11 IRON, CENTER-GUIDED, SPRING-LOADED CHECK VALVES

A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal or Resilient Seat:

1. Manufacturers:

a. Watts.

b. Milwaukee Valve Co.

c. Nibco, Inc.

2. Description:

a. Standard: MSS SP-125.

b. CWP Rating: 200 psig (1380 kPa) 500 psig (3450 kPa).

c. Body Material: ASTM A 126, gray iron.

d. Style: Compact wafer or globe, spring loaded.

e. Seat: Bronze.

2.12 BRONZE GATE VALVES

A. Class 125, NRS or RS, Bronze Gate Valves:

1. Manufacturers:

a. Conbraco Industries, Apollo Valves

b. Milwaukee Valve Co.

c. Nibco, Inc.

2. Description:

a. Standard: MSS SP-80, Type 1.

b. CWP Rating: 200 psig (1380 kPa).

c. Body Material: Bronze with integral seat and screw-in bonnet.

d. Ends: Threaded or solder joint.

e. Stem: Bronze.

f. Disc: Solid wedge; bronze.

g. Packing: Asbestos free.

h. Handwheel: Malleable iron, bronze, or aluminum.

2.13 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:

1. Manufacturers:

a. Conbraco Industries, Apollo Valves

b. Milwaukee Valve Co.

c. Nibco, Inc.

2. Description:

a. Standard: MSS SP-70, Type I.

b. CWP Rating: 200 psig (1380 kPa).

c. Body Material: Gray iron with bolted bonnet.

d. Ends: Flanged.

e. Trim: Bronze.

f. Disc: Solid wedge.

g. Packing and Gasket: Asbestos free.

B. Class 125, OS&Y, Iron Gate Valves:

1. Manufacturers:

a. Conbraco Industries, Apollo Valves

b. Milwaukee Valve Co.

c. Nibco, Inc.

2. Description:

a. Standard: MSS SP-70, Type I.

b. CWP Rating: 200 psig (1380 kPa).

c. Body Material: Gray iron with bolted bonnet.

d. Ends: Flanged.

e. Trim: Bronze.

f. Disc: Solid wedge.

g. Packing and Gasket: Asbestos free.

2.14 CHAINWHEELS

A. Manufacturers:

1. Babbitt Steam Specialty Co.

2. Roto Hammer Industries.

3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to handwheels.

1. Sprocket Rim with Chain Guides: Ductile or cast iron, of type and size required for valve. Include zinc or epoxy coating.

2. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

2.15 PLASTIC VALVES

A. Comply with requirements for general-duty metal valves in Section 220523 "General-Duty Valves for Plumbing Piping."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Install appropriate dielectric fittings where valve is of dissimilar metal construction.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement or in the case of quarter-turn valves, full handle movement.

F. Install valve tags. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

G. Install chainwheels on operators for butterfly valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.

H. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.

3. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends or solder-joint valve-end.

2. For Copper Tubing, NPS 2-1/2 and larger: Flanged ends.

3. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.

4. For Steel Piping, NPS 2-1/2 and larger: Flanged ends.

C. Use gate valves for shutoff service only.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.

2. Two-piece, bronze ball valves with full port and bronze or brass trim.

3. Two-piece, bronze ball valves with regular port and bronze trim.

B. Pipe NPS 2-½ (DN 65) and Larger:

1. Steel and Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100):

2. Class 150, iron ball valves.

3. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.

4. Stainless steel, High-Performance Butterfly Valves: 150 psig.

C. Pipe NPS 2 (DN 50) and Smaller: Bronze swing check valves, Class 150, nonmetallic disc with soldered or threaded end connections.

D. Pipe NPS 2-½ (DN 65) and Larger Check Valves:

1. Iron swing check valves, Class 125, nonmetallic-to-metal seats with flanged end connections.

2. Iron, center-guided check valves, Class 125, compact wafer.

3. Iron, center-guided check valves, Class 125, globe or resilient seat with flanged end connections.

4. Iron, dual-plate check valves, Class 125, metal or resilient seat with flanged end connections.

5. Iron, single-plate check valves, Class 125, resilient seat with flanged end connections.

E. Pipe NPS 2 (DN 50)and Smaller: Bronze gate valves, Class 125, NRS RS with soldered or threaded ends.

F. Pipe NPS 2-½ (DN 65) and Larger: Iron gate valves, Class 125, OS&Y with flanged ends.

END OF SECTION 22 05 23

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SECTION 22 05 29 - HANGERS, SUPPORTS AND MISCELLANEOUS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

B. Related Sections:

1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 22 05 16 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.

3. Pipe stands.

4. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.

2. Design Calculations: Calculate requirements for designing trapeze hangers.

D. Welding certificates: Copy of certificates for welding procedures and operators.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

1. Pipe Hangers:

a. Anvil International

b. Cooper B-Line

c. Carpenter & Paterson, Inc.

d. National Pipe Hanger Corp.

2. Metal Framing System:

a. Anvil International

b. Cooper B-Line

c. Unistrut Corp.

d. Allied Tube and Conduit

e. Nibco Inc.

3. Thermal-Hanger Shield Inserts:

a. Carpenter & Paterson, Inc.

b. National Pipe Hanger Corp.

4. Powder-Actuated Fastener Systems:

a. Hilti, Inc.

b. ITW Ramset/Red Head.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.

3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

3. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

2. Standard: MFMA-4.

3. Channels: Continuous slotted steel channel with inturned lips.

4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

6. Metallic Coating: Electroplated zinc Hot-dipped galvanized Mill galvanized In-line, hot galvanized or Mechanically-deposited zinc.

7. Paint Coating: Vinyl Vinyl alkyd Epoxy Polyester Acrylic Amine or Alkyd.

8. Combination Coating: <Insert coating materials in order of application>.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.

2. Standard: Comply with MFMA-4.

3. Channels: Continuous slotted steel channel with inturned lips.

4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

6. Coating: Zinc Paint.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.7 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece plastic, stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

2. Base: Plastic, Stainless steel.

3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.

4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

2. Bases: One or more; plastic.

3. Vertical Members: Two or more protective-coated-steel channels.

4. Horizontal Member: Protective-coated-steel channel.

5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 07 72 00 "Roof Accessories" for curbs.

G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

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

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

O. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.

    b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.

    c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.

    d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09 91 13 "Exterior Painting." Section 09 91 23 "Interior Painting" and Section 09 96 00 "High-Performance Coatings."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).

10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).

11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).

12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction might occur.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb (340 kg).

    b. Medium (MSS Type 32): 1500 lb (680 kg).

    c. Heavy (MSS Type 33): 3000 lb (1360 kg).

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

   a. Horizontal (MSS Type 54): Mounted horizontally.

   b. Vertical (MSS Type 55): Mounted vertically.

   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 05 29

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SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 22 05 00 “Common Work Results for Plumbing”.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.

2. Warning signs and labels.

3. Pipe labels.

4. Stencils.

5. Valve tags.

6. Warning tags.

7. Access panel and door markers

1.3 ACTION SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch (0.8-mm) Stainless steel, 0.025-inch (0.64-mm) Aluminum, 0.032-inch (0.8-mm) or anodized aluminum, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

4. Fasteners: Stainless-steel rivets or self-tapping screws.

5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

6. Location: Accessible and visible.

7. Data:

a. Manufacturer, product name, model number, and serial number.
b. Capacity, operating and power characteristics, and essential data.
c. Labels of tested compliances.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

2. Letter Color: Black Blue Red White or Yellow.

3. Background Color: Black Blue Red White or Yellow.

4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

9. Location: Accessible and visible.

10. Data:

    a. Name and plan number.
    b. Equipment service.
    c. Design capacity.
    d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

C. Label Content: In addition to the data requirements identified above, include equipment's Drawing designation or unique equipment number. Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

E. Minimum Label Size: Length and width vary for required label content, but not less than 3 by 5 1/4 inch (75 by 133 mm).

F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Brass grommet and wire.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions. Include large size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches (38 mm)high.

E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils (0.08 mm) thick with pressure-sensitive, permanent-type, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 inches (150 mm) : 3/4 inch (19 mm) minimum.

2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches (150 mm) or Larger: 1-1/2 inches (38 mm) minimum.

F. Colors: Comply with ASME A13.1, unless otherwise indicated.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Fiberboard or metal

2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.

3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers. Provide 5/32 inch (4 mm) hole for fastener.

1. Tag Material: Brass, 0.032-inch (0.8-mm) or Stainless steel, 0.03752-inch (1mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.

2. Frame: Finished hardwood or Extruded aluminum.

3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.

2. Fasteners: Reinforced grommet and wire or string.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

2.7 ACCESS PANEL AND DOOR MARKERS

A. Access Panel and Door Markers: 1/16 inch (1.6 mm) thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8 inch (3.2 mm) center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 inches (150 mm) : Pretensioned pipe markers. Use size to ensure a tight fit.

2. Pipes with OD, Including Insulation, Less Than 6 inches (150 mm): Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4 inch (19 mm) 1-1/2 inches (38 mm) wide, lapped at least 1-1/2 inches (38 mm) at both ends of pipe marker, and covering full circumference of pipe.

3. Pipes with OD, Including Insulation, 6 inches (150 mm) and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.

4. Pipes with OD, Including Insulation, 6 inches (150 mm) and Larger: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 1-1/2 inches (38 mm) wide, lapped at least 3 inches (75 mm) at both ends of pipe marker, and covering full circumference of pipe.

B. Stenciled Pipe Marker Option: Stenciled markers may be provided instead of manufactured pipe markers, at Installer's option. Install stenciled pipe markers complying with ASME A13.1 on each piping system.

1. Identification Paint: Use for contrasting background.

2. Stencil Paint: Use for pipe marking.

C. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 mm) in areas of congested piping and equipment.

7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; convenience and lawn-watering hose connections; and terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following:

1. Valve-Tag Size and Shape:

   a. Cold Water: 2 inches (50 mm), round.
   b. Hot Water: 2 inches (50 mm), round.
   c. Gas: 2 inches (50 mm), round.

2. Valve-Tag Color:

   a. Cold Water: Natural.
   b. Hot Water: Natural.
   c. Gas: Natural.

3. Letter Color:

   a. Cold Water: White.
   b. Hot Water: White.
   c. Gas: White.

3.5 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.7 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.8 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 22 05 53

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SECTION 22 11 16 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DEFINITIONS

A. Recycled water: Non-potable water from any source (storm, sanitary, ground, surface, etc.) which is collected, treated in accordance with applicable standards and authorities requirements, stored, distributed, and used for building water supply needs, including but not limited to water closets and urinal flushing, irrigation, cooling tower or other mechanical make-ups, laundry, window washing, etc.

B. See section 22 05 00 “Common Work Results for Plumbing” for other definitions.

1.3 SUMMARY

A. Section Includes:

1. Under-building-slab, in-ground and aboveground water pipes, tubes, and fittings inside buildings and up to the connection to water main or civil trade service.

2. Encasement for piping.

B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

C. Related Sections:

1. Section 22 11 19, “Domestic Water Piping Specialties”

D. Performance Requirements

1. Provide components and installation capable of producing domestic water piping systems with a minimum pressure rating, unless otherwise indicated:

a. Water service piping 160 psig (1100 kPa).

b. Water distribution piping – 125 psig (860 kPa).

E. UL Grounding And Bonding

1. Metal water piping shall be bonded to the grounding electrode in accordance with the requirements of the NEC (250.104-A-1). Groove lock fittings that are UL listed for grounding and bonding shall be permitted without either a jumper across each fitting or a ground loop to ground each section of pipe. Groove lock fittings that are not UL listed for grounding and bonding shall not be permitted. All domestic water piping of dissimilar materials shall be grounded independent of other materials; do not connect across the di-electric fittings.

1.4 GENERAL

A. Refer to the schedule of materials on drawings for materials and components acceptable for each system.

B. Use only approved fire proofing methods that shall match the piping materials for each system and shall be approved for such installation.

C. Use only fire proofing materials compatible with the piping materials and all other components in contact with the fire proofing.

D. Any request to use alternate materials must be approved in writing by Ownership and must identify clearly where the alternate materials will be installed.

E. When using alternate materials, coordinate additional requirements such as material compatibility, expansion and contraction, fire proofing, etc.

1.5 PRODUCT SUBMITTALS

A. Product Data: All products specified for this project as listed in Section 2.

1.6 LEED SUBMITTALS

A. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

B. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.7 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.8 QUALITY ASSURANCE

A. Welders installing domestic water piping shall be qualified in accordance with the ASME Boiler and Pressure Vessel Code, Section IX.

B. Welder qualification testing shall be performed by an approved agency and the inspector witnessing the test shall be an authorized American Welding Society - Certified Welding Inspector.

C. Copies of the certified welder qualification reports shall be maintained by both the approved agency and the licensed master plumber employing the welder(s) for at least six years and shall be made available upon request.

1.9 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt existing water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of water service.

2. Do not interrupt water service without Construction Manager's written permission.

3. Provide fire watch during fire service interruptions as required by local authorities, building rules or insurance.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 61.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type K and L (ASTM B 88M, Type B) water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B) water tube, annealed temper. This tube only permitted for ice-makers or coffee makers connection or similar.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:

1. MSS SP-123.

2. Cast-copper-alloy, hexagonal-stock body.

3. Ball-and-socket, metal-to-metal seating surfaces.

4. Solder-joint or threaded ends.

G. Copper-Tube, Extruded-Tee Connections:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

   a. T-Drill Industries Inc.

2. Description: Tee formed in copper tube according to ASTM F 2014.

H. Appurtenances for Grooved-End Copper Tubing:

1. General: Permitted only for non-pumped systems with less than 80 psi pressure.

2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

   a. Anvil International.

   b. Shurjoint Piping Products.

   c. Victaulic Company.

3. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.

4. Mechanical Couplings for Grooved-End Copper Tubing:

   a. Copper-tube dimensions and design similar to AWWA C606.

   b. Ferrous housing sections.

   c. EPDM-rubber gaskets suitable for hot and cold water.

   d. Bolts and nuts.

   e. Minimum Pressure Rating: 300 psig (2070 kPa).

2.3 COPPER TUBING FOR ELEVATED PRESSURE

A. For pump discharge or gravity line for pressures up to 250 psi: Copper tubing seamless drawn or extruded tubing Type "L" hard tempered as scheduled, in accordance with ASTM B-88 with brazed end fittings.

2.4 DUCTILE-IRON PIPE AND FITTINGS – FOR WATER SERVICES ONLY

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.

2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.

2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Push-on-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51.

2. Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

E. Standard-Pattern, Push-on-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.

2. Gaskets: AWWA C111/A21.11, rubber.

F. Compact-Pattern, Push-on-Joint Fittings:

1. AWWA C153/A21.53, ductile iron.

2. Gaskets: AWWA C111/A21.11, rubber.

G. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.

2.5 STAINLESS-STEEL PIPING

A. Potable-water piping and components shall comply with NSF 61.

B. Stainless-Steel Pipe: ASTM A 312/A 312M, Schedule 40.

C. Stainless-Steel Pipe Fittings: ASTM A 815/A 815M.

D. Appurtenances for Grooved-End, Stainless-Steel Pipe:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Anvil International.

b. Grinnell Mechanical Products; Tyco Fire Products LP.

c. Shurjoint Piping Products.

d. Victaulic Company.

2. Fittings for Grooved-End, Stainless-Steel Pipe: Stainless-steel couplings with dimensions matching stainless-steel pipe.

3. Mechanical Couplings for Grooved-End, Stainless-Steel Pipe:

a. AWWA C606 for stainless-steel-pipe dimensions.

b. Stainless-steel housing sections.

c. Stainless-steel bolts and nuts.

d. EPDM-rubber gaskets suitable for hot and cold water.

e. Minimum Pressure Rating: 600 psig (4137 kPa).

2.6 COPPER PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.

2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.7 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.

2. Pressure rating at least equal to pipes to be joined.

3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Cascade Waterworks Manufacturing.

b. Dresser, Inc.; Piping Specialties Products.

c. Ford Meter Box Company, Inc. (The).

d. JCM Industries.

e. Romac Industries, Inc.

f. Smith-Blair, Inc.; a Sensus company.

g. Viking Johnson.

2.8 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Central Plastics Company.

b. Hart Industries International, Inc.

c. Jomar International.

d. McDonald, A. Y. Mfg. Co.

e. Watts; a division of Watts Water Technologies, Inc.

f. Wilkins; a Zurn company.

2. Standard: ASSE 1079.

3. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).

4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Central Plastics Company.

b. Watts; a division of Watts Water Technologies, Inc.

c. Wilkins; a Zurn company.

2. Standard: ASSE 1079.

3. Factory-fabricated, bolted, companion-flange assembly.

4. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).

5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Nonconducting materials for field assembly of companion flanges.

3. Pressure Rating: 150 psig (1035 kPa).

4. Gasket: Neoprene or phenolic.

5. Bolt Sleeves: Phenolic or polyethylene.

6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Elster Perfection Corporation.

b. Grinnell Mechanical Products; Tyco Fire Products LP.

c. Precision Plumbing Products, Inc.

d. Victaulic Company.

2. Standard: IAPMO PS 66.

3. Electroplated steel nipple complying with ASTM F 1545.

4. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C).

5. End Connections: Male threaded or grooved.

6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105/A21.5, see drawings for extent of installation.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 22 11 19 "Domestic Water Piping Specialties" and requirements of local authorities.

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Where indicated on the drawings, install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 22 11 19 "Domestic Water Piping Specialties."

G. Install domestic water piping level and plumb.

H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

L. Install piping to permit valve servicing.

M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

Q. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping."

R. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 22 11 23 "Domestic Water Pumps."

S. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 22 05 19 "Meters and Gages for Plumbing Piping."

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

W. Install piston type expansion joints and/or expansion loops for all plastic piping per manufacturer's recommendations; install expansion joints or loops on every vertical metal piping riser longer than 100 feet.

3.3 JOINT CONSTRUCTION

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

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

G. Joint Construction for Grooved-End Copper Tubing (Permitted only in non-pumped applications, less than 80 psi Pressure): Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

H. Welded Joints for Stainless Steel Piping: Construct joints according to AWS Standards, using qualified processes and welding operators according to "Quality Assurance" Article. Shop weld pipe joints where welded piping is indicated. Use welded joints for piping within 50 feet height of the house pump or main water booster.

I. Joint Construction for Grooved-End Stainless Steel Piping: (Permitted only higher than 50 feet above the house pump or booster) Make joints according to AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

J. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

K. All joints shall be welded in accordance with ASME B31.9, inspected and tested in accordance with the Plumbing Code.

L. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.

2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings, couplings or nipples, or unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100) Use dielectric flanges, flange kits or nipples.

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger, support products, and installation in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.

2. Individual, Straight, Horizontal Piping Runs:

   a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.

   b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.

   c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.

2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.

3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.

4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.

5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.

6. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.

7. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.

E. Install supports for vertical copper tubing every floor, but no more than 10 feet (3 m).

F. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect water risers piping to horizontal distribution and water-service piping with shutoff valves; extend and connect to the following:

1. Tanks and Water Heaters: Cold water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater or tank connections.

2. Plumbing Fixtures: Cold and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

3. Equipment and Appliances Required Water Connections: Cold and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

C. Provide warning signs “Non-Potable Water, Do Not Drink” at every 15 feet of recycled water piping length, unless warning signs are factory applied.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.

2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.

d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

   a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

   b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

   c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

   d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, but not less than 150 PSI, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

   e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.

   f. Prepare reports for tests and for corrective action required.

   g. In multizone highrise buildings, each pressure zone piping shall be tested separately from the other zone. Temporary pipe jumpers between different zones and between cold and hot piping are not permitted.

   h. Air test is not permitted as final test. Air test could be performed by the contractor as preliminary test for self-check purpose only.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.

2. Open shutoff valves to fully open position.

3. Open throttling valves to proper setting.

4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.

   b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.

6. Remove and clean strainer screens. Close drain valves and replace drain plugs.

7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.

8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Unless other method required by local authorities, clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.

b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.

2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

d. Repeat procedures if biological examination shows contamination.

e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic or recycled water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.

b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Building-domestic water only service piping, NPS 1 to NPS 8 (DN 25 to DN 200) and larger, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.

2. Mechanical-joint, ductile-iron pipe; standard- or compact- pattern, mechanical-joint fittings; and mechanical joints.

3. Push-on-joint, ductile-iron pipe; standard- or compact- pattern, push-on-joint fittings; and gasketed joints.

4. Plain-end, ductile-iron pipe; flanged-joint, ductile-iron-pipe appurtenances; and flanged joints.

5. Stainless steel piping Type 304/304L or 316/316L ASTM A312 ASTMA778.

E. Combined domestic water, building-service and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300), shall be one of the following:

1. Mechanical-joint, ductile-iron pipe; standard- or compact- pattern, mechanical-joint fittings; and mechanical joints.

2. Push-on-joint, ductile-iron pipe; standard- or compact- pattern, push-on-joint fittings; and gasketed joints.

3. Plain-end, ductile-iron pipe; flanged-joint, ductile-iron-pipe appurtenances; and flanged joints.

4. Stainless steel piping Type 304/304L or 316/316L ASTM A312 ASTMA778.

F. Aboveground water piping, NPS 2 (DN 50) and smaller shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) ASTM B 88; cast- or wrought- copper, solder-joint fittings; and brazed soldered joints.

2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper push-on-joint fittings; and push-on joints.

3. Hard copper tube – grooved fittings, grooved joints, keyed couplings – to be used only on non-pumped systems, maximum 80 psi pressure.

4. ½" piping permitted only for individual fixtures connections less than five feet long.

G. Aboveground water piping, NPS 2-1/2 to NPS 8 (DN 65 to DN 200), shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought-copper, solder-joint fittings; and brazed soldered joints.

2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); grooved-joint, copper-tube appurtenances; and grooved joints. Permitted only for non-pumped systems less than 80 psi pressure.

3. Stainless-steel pipe Schedule 40; cut grooved-joint, stainless-steel-pipe appurtenances; cut grooved joints permitted only fifty feet an higher above house pump level, welded joints at house pump level and up to fifty feet above.

3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use full port ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly, full port ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.

2. Throttling Duty: Use full port ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or full port ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.

3. Hot-Water Circulation Piping, Balancing Duty: Calibrated or Memory-stop balancing valves.

4. Drain Duty: Hose-end drain valves, standard port permitted.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Use dual check valves with air gap complying with ASSE 1022 for water supply connections to carbonated, non-carbonated beverage dispensers, coffee makers.

END OF SECTION 22 11 16

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SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Applicable NSF and ASSE Standards, latest edition, unless different edition referred by local authorities.

C. Local code and Health Department rules and regulations.

1.2 DEFINITIONS

A. Recycled water: Non-potable water from any source (storm, sanitary, ground, surface, etc.) which is collected, treated in accordance with applicable standards and authorities requirements, stored, distributed, and used for building water supply needs, including but not limited to water closets and urinal flushing, irrigation, cooling tower or other mechanical make-ups, laundry, window washing, etc.

B. See section 22 05 00 “Common Work Results for Plumbing” for other definitions.

1.3 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Primary backflow preventers.
3. Secondary backflow preventers.
4. Water pressure-reducing valves.
5. Balancing valves.
6. Pressure sustaining valve.
7. Temperature-actuated, water mixing valves.
8. Strainers.
9. Clothes washer and ice maker outlet boxes.
10. Hose stations.
11. Hose bibbs.
12. Hydrants.

13. Drain valves.

14. Water-hammer arresters.

15. Air vents.

16. Trap-seal primer systems.

17. Flexible connectors.

18. Water submeters.

19. Remote registration system

20. Point of use water filters.

21. Pressurized water storage tanks.

B. Related Requirements:

1. Section 22 05 19 "Meters and Gauges for Plumbing Piping" for thermometers, pressure gauges, and flow meters in water piping.

2. Section 22 32 00 "Water Filtration Equipment" for central water filters in domestic water piping.

3. Section 22 41 00 "Plumbing Fixtures" for water filters for water coolers and drinking fountains.

1.4 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:

1. Domestic Water Distribution Piping: 125 psig (860 kPa).

2. Domestic Water Express Risers as required, see riser diagrams.

1.5 PRODUCT SUBMITTALS

A. Project specific product data for each product listed in Section 1.2: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections:

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Water hammer arresters submittal shall include manufacturer sizing installation and selection guide with specific models selected and indicated. Selection shall be based on actual field conditions, pipe length, size, fixtures, manufacturer's recommendations, etc.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For project specific water piping specialties to include in emergency, operation, and maintenance manuals.

B. Testing reports.

1.8 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of plumbing specialties and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Plumbing specialties shall bear label, stamp, date and other markings of specified testing agency.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.

E. NSF Compliance:

1. Comply with NSF 61, "Drinking Water System Components--Health Effects, Sections 01 through 09," for potable domestic water plumbing specialties.

2. ASME Compliance for Steel Tanks: Fabricate and label steel, ASME-code, water storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

F. Test and inspect water storage tanks according to the following tests and inspections and prepare test reports:

1. Pressure Testing for ASME-Code, Water Storage Tanks: Hydrostatically test to ensure structural integrity and freedom from leaks. Fill tanks with water, vent air, pressurize to 1-1/2 times tank pressure rating, disconnect test equipment, hold pressure for 30 minutes with no drop in pressure, and check for leaks.

2. Pressure Testing for Non-ASME-Code, Pressure, Water Storage Tanks: Hydrostatically test to ensure structural integrity and freedom from leaks at pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Fill tanks with water, vent air, pressurize tanks, disconnect test equipment, hold pressure for two hours with no drop in pressure, and check for leaks.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Water Filter Cartridges: Equal to 200 percent of amount installed for each type and size indicated.

2. Operating Key Handles: Equal to 100 percent of amount installed for each key-operated hose bibb and hydrant installed.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61.

2.2 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers for non-continuous upstream pressure.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.

b. Apollo Valves

c. Watts Regulator Company.

d. Wilkins Water Control Products.

2. Standard: ASSE 1001.

3. Operation: Non-continuous pressure, no back pressure.

4. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.

5. Body: Bronze.

6. Inlet and Outlet Connections: Threaded.

7. Finish: Rough bronze in back of the house or concealed Chrome plated if exposed to public view.

8. Accessories: Shut-off valves not permitted downstream.

B. Hose-Connection Vacuum Breakers for non-continuous upstream pressure:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

   a. Apollo Valves

   b. MIFAB, Inc.

   c. Watts Regulator Company.

   d. Woodford Manufacturing Company.

   e. Wilkins Water Control Products

2. Standard: ASSE 1011.

3. Operation: Non-continuous pressure, no back pressure.

4. Body: Bronze, nonremovable, with manual drain.

5. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.

6. Finish: Chrome or nickel plated.

7. Accessories: Shut-off valves not permitted downstream.

C. Pressure Vacuum Breakers for continuous upstream pressure:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

   a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.

   b. Apollo Valves

   c. Watts Regulator Company.

   d. Wilkins Water Control Products.

2. Standard: ASSE 1020.

3. Operation: Continuous-pressure applications, no back pressure.

4. Pressure Loss: 5 psig (35 kPa) maximum, through middle third of flow range.

5. Accessories: Ball type, on inlet and outlet.

D. Laboratory-Faucet Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

   a. Apollo Valves

   b. Watts Regulator Company.

   c. Woodford Manufacturing Company.

   d. Wilkins Water Control Products.

2. Standard: ASSE 1035.

3. Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10) matching faucet size.

4. Body: Bronze.

5. End Connections: Threaded.

6. Finish: Chrome plated.

E. Spill-Resistant Vacuum Breakers for indoor applications where spillage is not acceptable:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

   a. Conbraco Industries, Inc.

   b. Watts Regulator Company.

   c. Wilkins Water Control Products.

2. Standard: ASSE 1056.

3. Operation: Continuous-pressure applications, no back pressure.

4. Accessories: Ball type, on inlet and outlet.

2.3 PRIMARY BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with utility company requirements, provide products approved by the utility company.

2. With absence of utility requirements provide the product indicated on Drawings or a comparable product by one of the following:

a. Ames Fire & Waterworks.

b. Apollo Valves

c. Watts Water Technologies, Inc.

d. Wilkins; a Zurn company.

e. Cla-Val

3. Standard: ASSE 1013 or AWWA C511.

4. Operation: Continuous-pressure applications.

5. Pressure Loss: 12 psig (83 kPa) maximum, through middle 1/3 of flow range.

6. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 (DN 65) and larger.

7. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.

8. Accessories:

a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.

B. Double-Check, Backflow-Prevention Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products approved by utility company.

2. With absence of provide the product indicated on Drawings or a comparable product by one of the following:

a. Ames Fire & Waterworks.

b. Apollo Valves.

c. Watts Water Technologies, Inc.

d. Wilkins; a Zurn company.

3. Standard: ASSE 1015 or AWWA C510.

4. Operation: Continuous-pressure applications, unless otherwise indicated.

5. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.

6. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 (DN 65) and larger.

7. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.

8. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

C. Reduced-Pressure-Detector, Fire-Protection Backflow Preventer Assemblies:

1. Manufacturers: Subject to compliance with utility company requirements, provide products approved by utility company.

2. With absence of requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. Ames Fire & Waterworks; a division of Watts Regulator Co.

   b. Apollo Valves.

   c. Watts Water Technologies, Inc.

   d. Wilkins; a Zurn company.

3. Standards: ASSE 1047 and UL listed or FMG approved.

4. Operation: Continuous-pressure applications.

5. Pressure Loss: 12 psig (83 kPa) maximum, through middle 1/3 of flow range.

6. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved or Stainless steel.

7. End Connections: Flanged.

8. Accessories:

   a. Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.

   b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.

   c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

D. Double-Check, Detector-Assembly Backflow Preventers:

1. Manufacturers: Subject to compliance with utility company requirements, provide products acceptable by utility company.

2. With absence of requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. Ames Fire & Waterworks; a division of Watts Regulator Co.

   b. Apollo Valves.

   c. Watts Water Technologies, Inc.

   d. Wilkins; a Zurn company.

3. Standards: ASSE 1048 and UL listed or FMG approved.

4. Operation: Continuous-pressure applications.

5. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.

6. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved or Stainless steel.

7. End Connections: Flanged.

8. Accessories:

   a. Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.

   b. Bypass: With utility company displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

E. Backflow Preventer Test Kits:

1. Manufacturers: Same as selected backflow preventer manufacturer.

2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.4 SECONDARY BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers for certain types of kitchen equipment, but not for carbonated beverage dispensers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Apollo Valves.

b. Honeywell International Inc.

c. Watts Regulator Company.

d. Wilkins Water Control Products.

2. Standard: ASSE 1012.

3. Operation: Continuous-pressure applications.

4. Size: NPS 1/2 (DN 15) or NPS 3/4 (DN 20).

5. Body: Bronze.

6. End Connections: Union, solder or Solder joint.

7. Finish: Chrome plated or Rough bronze.

8. Accessories:

a. Fixed air gap and drain.

b. Shut-off valve.

B. Reduced-Pressure-Principle Backflow Preventers, for certain types of kitchen equipment:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.

b. Apollo Valves

c. Watts Water Technologies, Inc.

2. Standard: ASSE 1013.

3. Operation: Continuous-pressure applications, subject to back pressure.

4. Pressure Loss: 12 psig (83 kPa) maximum, through middle third of flow range.

5. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 (DN 65) and larger.

6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged or grooved for NPS 2-1/2 (DN 65) and larger.

7. Configuration: Designed for horizontal, straight-through vertical-inlet, horizontal-center-section, and vertical-outlet flow.

8. Accessories:

   a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.

   b. Valves NPS 2-1/2 (DN 65) and Larger: Non-rising stem (NRS) gate type with flanged ends on inlet and outlet.

   c. Fixed Air-Gap Fitting: ASME A112.1.2, size matching backflow-preventer connection.

C. Double-Check, Backflow-Prevention Assemblies:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.

   b. Apollo Valves.

   c. Watts Regulator Company.

   d. Wilkins Water Control Products.

2. Standard: ASSE 1015.

3. Operation: Continuous-pressure applications unless otherwise indicated.

4. Pressure Loss: 5 psig (35 kPa) maximum, through middle third of flow range.

5. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 (DN 65) and larger.

6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged, or grooved for NPS 2-1/2 (DN 65) and larger.

7. Accessories:

   a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.

   b. Valves NPS 2-1/2 (DN 65) and Larger: Non-raising stem (NRS) gate type with flanged ends on inlet and outlet.

D. Dual check valves with atmospheric port for Carbonated and Non-Carbonated, Beverage-Dispensing-Equipment Backflow Preventers, espresso machines backflow preventers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company. Model SD-2,

      Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products. Model 740

   b. Anderson Brass Co Model ABF-1

2. Backflow preventer supplied as integral part of beverage dispenser will be acceptable, if the device meets requirements of this section.

3. Standard: ASSE 1022.

4. Operation: Continuous-pressure applications.

5. Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10) only.

6. Body: Stainless steel.

7. End Connections: Threaded.

8. Accessories:

   a. Fixed air gap and drain.

   b. Shut-off valve

   c. Plastic tubing downstream of the backflow preventer.

E. Dual-Check-Valve Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Apollo Valves

   b. Mueller Water Products Inc.

   c. Watts Regulator Company.

   d. Wilkins Water Control Products.

2. Standard: ASSE 1024.

3. Operation: Continuous-pressure applications.

4. Size: NPS 1/2 (DN 15) NPS 3/4 (DN 20) NPS 1 (DN 25) NPS 1-1/4 (DN 32).

5. Body: Bronze with union inlet.

F. Dual-Check-Valve Standard ASSE 1032-shall not be used as backflow preventer:

G. Hose-Connection Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Apollo Valves

b. Watts Regulator Company.

c. Woodford Manufacturing Company.

d. Wilkins

2. Standard: ASSE 1052.

3. Operation: Up to 10-foot head of water (30-kPa) back pressure.

4. Inlet Size: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).

5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.

6. Capacity: At least 3-gpm (0.19-L/s) flow.

H. Backflow-Preventer Test Kits:

1. Manufacturers: Same as selected backflow preventer manufacturer.

2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.5 WATER PRESSURE-REDUCING VALVES

A. Branch Water Pressure Reducing Valves:

1. General: Shall maintain a constant downstream pressure (plus or minus 3 PSI) regardless of changing inlet pressures and/or flow rates. All flow conditions from zero to full flow are to be handled in a stable manner. The valve shall close drop tight when the downstream pressure rises to the setting of the spring. No pressure "creep" or leak can be tolerated. Valve body and cover shall be of an all bronze construction. The trim shall be 416 stainless steel. The valve shall contain an integral chrome nickel stainless steel strainer.

All repairs shall be possible without removing the valve body from the line. The valve body shall be constructed of NPT union tail pieces at the inlet and outlet of the valve.

2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

   a. Apollo Valves

   b. Honeywell International Inc.

   c. Watts Regulator Company.

   d. Wilkins Water Control Products.

3. Standard: ASSE 1003.

4. Pressure Rating: Maximum working pressure of 300 psig (2070 kPa).

5. Design Outlet Pressure Setting: 25 to 75psi.

6. Body: Bronze with chrome-plated finish for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

7. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

B. Main Pressure Reducing Valves:

1. General:

   a. Provide zones pressure regulating valve rigs to control the water pressure sizes as indicated on the drawings and detail. Valve rigs shall consist of the following: Shall maintain a constant downstream pressure plus or minus 1% of the set pressure regardless of fluctuations in demand and/or varying inlet pressures. The valve shall be capable of keeping the outlet pressure constant from zero flow to maximum rated flow. No low flow chatter or hunting will be acceptable.

2. Provide a nickel stainless steel strainer before each assembly.

3. Low-Flow main pressure reducing valve shall be the same as noted here-in for branch pressure reducing valves.

4. See detail on drawings for valve arrangement and sizes.

5. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. CLA-VAL.

b. Bermad.

c. Watts Water Technologies, Inc..

d. Wilkins Water Control Products.

e. Singer

6. Hi-Flow main pressure reducing valves are to be pilot operated, hydraulically controlled, diaphragm type globe valves. Valves to have a single removable seat and a resilient disc. The stem shall be guided at both ends by a bearing in the cover and a bearing in the valve seat.

7. Pressure Rating: Maximum working pressure of 300 psig (2070 kPa) minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.

8. Main Valve Body: Cast- or ductile-iron or all bronze body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.

   a. Size: See drawings.

   b. Pattern: Angle or Globe-valve design.

   c. Trim: Stainless steel.

9. Design Flow: See drawings.

10. Design Inlet and Outlet Pressure: See drawings

11. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.

C. Excess Pressure Shutoff Valve:

1. Excess pressure shutoff valve shall close drop tight if the pressure at the valve inlet rises above the set point of the pilot control and shall remain closed until the inlet pressure drops below the set point of the control and the manual reopening control has been opened to reset the main valve. The valve shall be cast iron with bronze trim and all cast iron wetted parts shall be epoxy-coated by the fusion process.

2. The pilot control shall be a direct-acting adjustable, springloaded, normally open diaphragm valve, designed to permit flow when inlet controlling pressure is less than the spring setting.

3. The control system shall incorporate a manual locking valve designed to keep the valve in the closed position when it has once been actuated to the closed position. The valve shall be so mounted that if the main valve diaphragm ruptures the valve will go closed.

4. Excess Pressure Shutoff Safety Valve Operation

   a. Under normal conditions the excess shutoff safety valve will be open. The pressure relief control is normally closed and responds to inlet pressure changes. An increase in inlet pressure tends to open the control. When inlet pressure is higher than the set point of the control, the control opens. This pressurizes the cover of the main valve and the main valve closes, and remains closed until it is reset.

   b. The main valve shall be sized and located as shown on the drawings and as described in these specifications. The valve body and cover shall be cast bronze ASTM B-62. The valve shall be supplied with 150 ASA screwed ends, and bronze trim.

   c. The main valve shall be hydraulically operated and diaphragm-actuated and shall contain a resilient, synthetic rubber disc, having a rectangular cross-section, contained on three sides by a disc retainer and forming a tight seal, against a single removable seat insert. The diaphragm assembly containing a valve stem shall be fully guided at both ends by a bearing in the cover an integral bearing in the valve seat. This diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. The diaphragm shall consist of nylon fabric bonded with synthetic rubber. Packing glands and/or stuffing boxes are not permitted in the main valve or any of the controls. All necessary repairs shall be possible without removing the main valve body from the line.

   d. The pilot control shall be a direct-acting, adjustable, spring-loaded, diaphragm valves, designed to permit flow when controlling pressure exceeds the spring setting, it shall be adjustable from 0-75 psi.

   e. Provide hi-pressure flow switch wired back to remote building alarm panel when valve is closed.

2.6 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

      a. Armstrong International, Inc.

      b. Nexus.

      c. ITT Corporation; Bell & Gossett Div.

      d. NIBCO Inc.

      e. TACO Incorporated.

f. Watts Regulator Company.

2. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.

3. Body: Brass or bronze.

4. Size: Same as connected piping, but not larger than NPS 2 (DN 50).

5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Cast-Iron Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Apollo Valves.

b. Nexus.

c. ITT Corporation; Bell & Gossett Div.

d. NIBCO Inc.

e. TACO.

f. Watts Regulator Company.

2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.

3. Size: Same as connected piping, but not smaller than NPS 2-1/2 (DN 65).

4. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

C. Memory-Stop Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Apollo Valves

b. Crane Valves.

c. Stockham Valves.

d. Hammond Valve.

e. Milwaukee Valve Company.

f. NIBCO Inc.

2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.

3. Pressure Rating: 400-psig (2760-kPa) minimum CWP.

4. Size: NPS 2 (DN 50) or smaller.

5. Body: Copper alloy.

6. Port: Standard or full port.

7. Ball: Chrome-plated brass.

8. Seats and Seals: Replaceable.

9. End Connections: Solder joint or threaded.

10. Handle: Vinyl-covered steel with memory-setting device.

2.7 PRESSURE SUSTAINING VALVES

A. Fast Opening, Slow Closing Completely Automatic Pressure Sustaining Valve:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. CLAVAL Model 550-01, 6550-01.

b. Bermad. Model 73D

c. Singer. Model 106-DG

2. Type: Hydraulically operated, pilot controlled modulating valve.

3. Body: 316 Series stainless steel, electropolished, full port.

4. Pressure Rating: ANSI Class 150 max 285 psi.

2.8 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Armstrong International, Inc.

b. Apollo Valves

c. Honeywell International Inc.

d. Leonard Valve Company.

e. Symmons Industries, Inc.

f. TACO Incorporated.

g. Watts Regulator Company.

h. Wilkins Water Control Products.

2. Standard: ASSE 1070.

3. Pressure Rating: 125 psig (860 kPa).

4. Type: Thermostatically controlled, water mixing valve.

5. Material: Bronze body with corrosion-resistant interior components.

6. Connections: Threaded or union inlets and outlet.

7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

8. Valve Finish: Chrome plated.

B. Primary, Thermostatic, Water Mixing Valves and Valve Stations:

1. Manufacturers: Subject to compliance with all project requirements (flow, pressure rating, allowable pressure loss, space requirements), provide one of the following:

a. Holby.

b. Armstrong International, Inc.

c. Lawler Manufacturing Company, Inc.

d. Leonard Valve Company.

e. Powers; a division of Watts Water Technologies, Inc. (Base of design)

f. Symmons Industries, Inc.

2. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets to each valve and shutoff valve on each outlet.

3. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.

4. Pressure Rating: 150 psig minimum working pressure unless otherwise indicated.

5. Type: Exposed-mounted or Cabinet-type, thermostatically controlled, water mixing valve stations. Where required by the design conditions provide water mixing-valve assembly in two or three-valve parallel arrangement to accommodate low/high flow conditions.

6. Maximum allowable pressure drop through the mixing valve station: 5 PSI.

7. Material: Bronze or stainless steel body with corrosion-resistant interior components. All wetted parts to be ANSI/NSF 372 compliant.

8. Connections: Threaded, union or flanged inlets and outlet.

9. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle or controller. Provide pressure gages on inlet and outlet of all mixing valves and mixing valve stations.

10. Valve Finish: Polished, chrome plated.

11. Cabinet: Factory fabricated, stainless steel, for recessed or surface mounting and with hinged, stainless-steel door.

12. Provide anti-scald measures as recommended by the valve manufacturer in case of valve failure.

C. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

   a. Apollo Valves

   b. Honeywell International Inc.

   c. Lawler Manufacturing Company, Inc.

   d. Leonard Valve Company.

   e. Watts Water Technologies, Inc.

   f. Wilkins Water Control Products.

2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.

3. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.

4. Body: Bronze body with corrosion-resistant interior components.

5. Temperature Control: Adjustable.

6. Inlets and Outlet: Threaded.

7. Finish: Rough or chrome-plated bronze.

2.9 STRAINERS FOR WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.

2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 (DN 65) and larger.

3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.

4. Screen: Stainless steel with round perforations unless otherwise indicated.

5. Perforation Size:

a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).

b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm).

c. Strainers NPS 5 (DN 125) and Larger: 0.10 inch (2.54 mm).

6. Drain: Pipe plug.

7. Strainers installed with water meters shall be of the same manufacturer as the water meter.

8. Strainers at the water meters shall be of the same manufacturer as the water meter itself.

2.10 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Acorn Engineering Company.

b. Oatey.

c. Symmons Industries, Inc. – Base of Design.

d. Watts Regulator Company.

e. Acorn Engineering Company.

f. Zurn Industries, LLC.

2. Mounting: Recessed.

3. Material and Finish: Enameled-steel or epoxy-painted-steel or Stainless-steel box and faceplate. Plastic box is not permitted.

4. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.

5. Supply Shutoff Fittings: NPS 1/2 (DN 15) gate, globe, or ball valves and NPS 1/2 (DN 15) copper, water tubing.

6. Drain: NPS 2 (DN 50) standpipe and P-trap for direct waste connection to drainage piping.

7. Inlet Hoses: Two 60-inch- (1500-mm-) long, heavy duty branded stainless steel clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.

8. Drain Hose: One 48-inch- (1200-mm-) long, rubber household clothes washer drain hose with hooked end.

9. Automatic Washing Machine Water Shutoff Valves with Leak Sensor.

    a. General automatic washing machine solenoid shutoff valves with Leak Sensor to protect against water damage from a burst inlet hose connected to a washing machine in use or unattended.

    b. The system shall be similar to Watts Series A2C IntelliFlow or approved equal. The system shall:

        1) Sense when the washing machine is on or off

        2) Opens or close the hot and cold inlet valves as needed to allow or prevent water from flowing to the washer.

        3) Detect water leak, close both solenoid valves on cold and hot water supply if the leak detected.

    c. The system consists of an electrical three-prong outlet to receive a washing machine power cable, leak sensor, a power cord and a replaceable internal strainer screen.

B. Icemaker Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

    a. Acorn Engineering Company.

b. IPS Corporation.

c. LSP Products Group, Inc.

d. Oatey.

2. Mounting: Recessed.

3. Material and Finish: Enameled-steel or epoxy-painted-steel Stainless-steel box and faceplate. Plastic box is not permitted.

4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 (DN 15) or smaller copper tube outlet.

5. Supply Shutoff Fitting: NPS 1/2 (DN 15) gate, globe, or ball valve and NPS 1/2 (DN 15) copper, water tubing.

2.11 HOSE STATIONS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

1. Armstrong International, Inc.

2. Leonard Valve Company.

3. T & S Brass.

B. Single-Temperature-Water Hose Stations:

1. Standard: ASME A112.18.1.

2. Cabinet: Stainless-steel enclosure with exposed valve handle, hose connection, and hose rack. Include thermometer in front.

3. Hose-Rack Material: Stainless steel.

4. Body Material: Bronze with stainless-steel wetted parts.

5. Body Finish: Rough bronze.

6. Mounting: Wall, with reinforcement or Floor, with stainless-steel pedestal.

7. Supply Fittings: gate, globe, or ball valve and check valve and copper, water tubing. Omit check valve if check stop is included with fitting.

8. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 50 feet (15 m) long.

9. Nozzle: With hand-squeeze, on-off control.

10. Vacuum Breaker:

    a. Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.

    b. Garden-hose thread complying with ASME B1.20.7 on outlet.

C. Hot- and Cold-Water Hose Stations or Steam and Cold Water Stations:

1. Standard: ASME A112.18.1.

2. Faucet Type: Blending Thermostatic mixing valve.

3. Cabinet: Stainless-steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.

4. Hose-Rack Material: Stainless steel.

5. Body Material: Bronze with stainless-steel wetted parts.

6. Body Finish: Rough bronze.

7. Mounting: Wall, with reinforcement or Floor, with stainless-steel pedestal.

8. Supply Fittings: Two gate, globe, or ball valves and check valves and copper, water tubing. Omit check valves if check stops are included with fitting.

9. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 50 feet (15 m) long.

10. Nozzle: With hand-squeeze, on-off control.

11. Vacuum Breaker: Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

2.12 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.

2. Body Material: Bronze.

3. Seat: Bronze, replaceable.

4. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.

5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.

6. Pressure Rating: 125 psig (860 kPa).

7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.

8. Finish for Equipment Rooms and service areas: Rough bronze.

9. Finish for Finished Rooms: Chrome or nickel plated.

10. Operation: Wheel handle or operating key.

11. Include operating key with each operating-key hose bibb.

12. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.13 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Josam Company.

b. MIFAB, Inc.

c. Wade.

d. Watts Drainage Products.

e. Woodford Manufacturing Company.

f. Zurn Industries, LLC; Plumbing Products Group.

2. Standard: ASME A112.21.3M for self-draining wall hydrants.

3. Pressure Rating: 125 psig (860 kPa).

4. Operation: Loose key.

5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.

6. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).

7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.

8. Box: Deep, flush mounted with cover.

9. Wall hydrants without integral vacuum breaker permitted for non-potable water only.

10. Box and Cover Finish: By Architect.

11. Operating Keys(s): With each wall hydrant.

B. Nonfreeze, Hot- and Cold-Water Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Josam Company.

   b. Tyler Pipe; Wade Div.

   c. Watts Drainage Products.

   d. Woodford Manufacturing Company.

   e. Zurn Industries, LLC; Plumbing Products Group.

2. Standard: ASME A112.21.3M for concealed or exposed-outlet, self-draining wall hydrants.

3. Pressure Rating: 125 psig (860 kPa).

4. Operation: Loose key.

5. Casing and Operating Rods: Of length required to match wall thickness. Include wall clamps.

6. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).

7. Outlet: Concealed.

8. Box: Deep, flush mounted with cover.

9. Box and Cover Finish: Polished nickel bronze or Chrome plated.

10. Vacuum Breaker:

   a. Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.

   b. Garden-hose thread complying with ASME B1.20.7 on outlet.

11. Operating Keys(s): One with each wall hydrant.

C. Vacuum Breaker Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

   a. Watts Regulator Company.

   b. Woodford Manufacturing Company; a division of WCM Industries, Inc.

   c. Zurn Industries, LLC; Plumbing Products Group.

2. Standard: ASSE 1019, Type A or Type B.

3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.

4. Classification: For automatic draining with hose removed.

5. Pressure Rating: 125 psig (860 kPa).

6. Operation: Loose key or wheel handle.

7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.

8. Inlet: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).

9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.14 GROUND HYDRANTS

A. Nonfreeze Ground Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

   a. Josam Company.

   b. MIFAB, Inc.

   c. Wade Div.

   d. Watts Drainage Products.

   e. Woodford Manufacturing Company.

   f. Zurn Industries, LLC; Plumbing Products Group.

2. Standard: ASME A112.21.3M.

3. Type: Nonfreeze, concealed-outlet ground hydrant with box.

4. Operation: Loose key.

5. Casing and Operating Rod: Of at least length required for burial of valve below frost line.

6. Inlet: NPS 3/4 (DN 20).

7. Outlet: Garden-hose thread complying with ASME B1.20.7.

8. Drain: Designed with hole to drain into ground when shut off.

9. Box: Standard or Deep pattern with cover.

10. Box and Cover Finish: By Architect.

11. Operating Key(s): Two with each ground hydrant.

12. Vacuum Breaker:

    a. Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.

    b. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.15 POST HYDRANTS

A. Nonfreeze, Draining-Type Post Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

    a. MIFAB, Inc.

    b. Simmons Manufacturing Co.

    c. Wade Div.

    d. Watts Drainage Products.

    e. Woodford Manufacturing Company.

    f. Zurn Industries, LLC.

2. Standard: ASME A112.21.3M.

3. Type: Nonfreeze, exposed-outlet post hydrant.

4. Operation: Loose key.

5. Casing and Operating Rod: Of at least length required for burial of valve below frost line.

6. Casing: Bronze with casing guard.

7. Inlet: NPS 3/4 (DN 20).

8. Outlet: Garden-hose thread complying with ASME B1.20.7.

9. Drain: Designed with hole to drain into ground when shut off.

10. Vacuum Breaker:

    a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.

    b. Garden-hose thread complying with ASME B1.20.7 on outlet.

11. Operating Key(s): One with each loose-key-operation wall hydrant.

B. Nonfreeze, Nondraining-Type Post Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

    a. Murdock-Super Secur; a division of Acorn Engineering Company.

    b. Wood Ford

2. Operation: Lever-piston operating mechanism and nondraining water-storage reservoir, designed without drain.

3. Length: As required for burial of valve below frost line.

4. Inlet: NPS 1 (DN 25) threaded.

5. Outlet:

    a. NPS 1 (DN 25) outlet and coupling plug for 1-inch (25-mm) hose.

    b. NPS 1 by NPS 3/4 (DN 25 by DN 20) adapter with nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.

    c. Garden-hose thread complying with ASME B1.20.7 on outlet.

    d. NPS 1 by NPS 3/4 (DN 25 by DN 20) adapter with nonremovable, drainable, hose-connection backflow preventer complying with ASSE 1052.

    e. Garden-hose thread complying with ASME B1.20.7 on outlet.

C. Freeze-Resistant Sanitary Non-Drinking Yard Hydrants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

   a. Hoeptner Products.

   b. Wood-Ford

2. Standard: ASSE 1057, Type 5 for nondraining hydrants.

3. Operation: Wheel handle.

4. Head: Copper alloy, with pail hook.

5. Inlet: NPS 3/4-inch (DN 20) threaded inlet and inlet nozzle, galvanized-steel riser, and venturi.

6. Canister: Zinc-plated steel with atmospheric-vent device.

7. Vacuum Breaker:

   a. Removable hose-connection backflow preventer complying with ASSE 1052.

   b. Garden-hose thread complying with ASME B1.20.7 on outlet for field installation.

2.16 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.

2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.

3. Size: NPS 1 (DN 25), unless larger size indicated on the drawings.

4. Body: Copper alloy.

5. Ball: Chrome-plated brass.

6. Seats and Seals: Replaceable.

7. Handle: Vinyl-covered steel.

8. Inlet: Threaded or solder joint.

9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 1 (DN 25), unless larger size indicated on the drawings.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 (DN 20) threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig (1380-kPa) minimum CWP or Class 125.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 (DN 6) side outlet with cap.

2.17 WATER-HAMMER ARRESTERS (SHOCK ABSORBERS)

A. Manufacturers:

1. Josam Company.
2. MIFAB, Inc.
3. Precision Plumbing Products, Inc.
4. Sioux Chief Manufacturing Company, Inc.
5. Tyler Pipe; Wade Div.
6. Watts.
7. Zurn Industries, LLC.

B. Standard: ASSE 1010 or PDI-WH 201.

C. Type: Metal bellows or Copper tube with piston.

D. Size and amount: As per manufacturer's recommendations and PDI-WH-201 standard, but no less than 1" pipe size. Exception: ¾" permitted on ¾" piping.

2.18 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.

2. Pressure Rating and Temperature: 125-psig (860-kPa) minimum pressure rating at 140 deg F (60 deg C).

3. Float: Replaceable, corrosion-resistant metal.

4. Mechanism and Seat: Stainless steel.

5. Size: NPS 1/2 (DN 15) minimum inlet.

6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.

2. Pressure Rating: 150-psig (1035-kPa) minimum pressure rating.

3. Float: Replaceable, corrosion-resistant metal.

4. Mechanism and Seat: Stainless steel.

5. Size: NPS 3/8 (DN 10) minimum inlet.

6. Inlet and Vent Outlet End Connections: Threaded.

2.19 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. MIFAB, Inc.

b. Precision Plumbing Products, Inc.

c. Sioux Chief Manufacturing Company, Inc.

d. Watts Regulator Company.

e. Kohler

2. Standard: ASSE 1018.

3. Pressure Rating: 125 psig (860 kPa) minimum.

4. Body: Bronze.

5. Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.

6. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) threaded or solder joint.

7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. MIFAB Inc.

b. Zurn

c. Precision Plumbing Products, Inc.

d. Kohler

2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 (DN 10) minimum, trap makeup connection.

3. Size: NPS 1-1/4 (DN 32) minimum.

4. Material: Chrome-plated, cast brass.

2.20 ELECTRONIC TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Precision Plumbing Products, Inc.

b. Zurn

c. MIFAB

2. Standard: ASSE 1044.

3. Piping: NPS 3/4, ASTM B 88, Type L (DN 20, ASTM B 88M, Type B); copper, water tubing.

4. Cabinet: Surface-mounted steel box with stainless-steel cover.

5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.

   a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

6. Vacuum Breaker: ASSE 1001.

7. Size Outlets: NPS 1/2 (DN 15).

2.21 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

1. Flex-Hose Co., Inc.

2. Flexicraft Industries.

3. Flex Pression, Ltd.

4. Flex-Weld Incorporated.

5. Metraflex, Inc.

6. Unaflex.Universal Metal Hose.

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).

2. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.

3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).

2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.

3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

D. Flexible connectors used for domestic water shall be NSF-61 approved.

2.22 WATER SUBMETERS

A. All submeters and their accessories shall comply with the latest edition of "Water company regulations".

B. Displacement-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Metron-Farnier.

b. Hersey.

c. Badger.

d. Sensus.

e. Neptune.

2. Description:

a. Standard: AWWA C700.

b. Pressure Rating: 150-psig (1035-kPa) working pressure.

c. Body Design: Nutating disc; totalization meter.

d. Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.

e. Case: Bronze.

f. End Connections: Threaded.

C. Turbine-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Badger Meter, Inc.

b. Sensus.

c. Neptune Inc.

2. Description:

a. Standard: AWWA C701.

b. Pressure Rating: 150-psig (1035-kPa) working pressure.

c. Body Design: Turbine; totalization meter.

d. Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.

e. Case: Bronze.

f. End Connections for Meters NPS 2 (DN 50) and Smaller: Threaded.

g. End Connections for Meters NPS 2-1/2 (DN 65) and Larger: Flanged.

D. Compound-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Metron-Farnier.

b. Badger Meter, Inc.

c. Master Meter, Inc.

d. Mueller Co. Ltd.

e. Schlumberger Limited.

f. Sensus.

g. Neptune, Inc.

2. Description:

a. Standard: AWWA C702.

b. Pressure Rating: 150-psig (1035-kPa) working pressure.

c. Body Design: With integral mainline and bypass meters; totalization meter.

d. Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.

e. Case: Bronze.

f. Pipe Connections: Flanged.

E. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

F. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

2.23 REMOTE REGISTRATION FOR UTILITY METERS AND SUB-METERS

A. Direct-Reading Type:

1. Description: Utility company standard; encoder type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.

a. Standard: AWWA C706.

b. Registration: Flow in gallons (liters) or cubic feet (cubic meters) as required by utility company.

c. This contractor is responsible for coordinating of wiring between water meter and remote reading device. Wiring by electrical trade.

B. Encoder Type:

1. Description: Utility company standard; encoder type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.

a. Standard: AWWA C706, C707.

b. Registration: Flow in gallons (liters) cubic feet (cubic meters) as required by utility company.

c. Data-Acquisition Units: Comply with utility company requirements for type and quantity.

d. Visible Display Units: Comply with utility company requirements for type and quantity.

2. All main building water meters shall use radio-based automatic meter reading system using AMR transmitters. Transmitters shall be mounted on the exterior surface of a building wall above ground level, unless otherwise specified by the water department AMR radio transmitters for cooling tower make-up water meters located on an upper floor of a building shall be mounted on the exterior of the building wall at a roof parapet or other location to remit effective transmission of the radio signal.

3. Meter Attachments

a. No customer shall attach any device to the water meter unless such device has been submitted to, and approved by, the department.

b. No device submitted for approval shall interfere with or affect the operation, inspection or reading of the meter in any way.

c. Any device approved shall be solely the responsibility of the customer unless it is installed by the Department. The Department shall not be liable for any maintenance or replacement of any approved attachments to the meter, and shall not perform any additional steps to salvage the devices should the meter require replacement.

2.24 POINT OF USE WATER FILTERS

A. Manufacturers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Filtrine Manufacturing Company.

b. U.S. Filter; Filterite Div.

c. Watts Industries, Inc.

d. Better Waters

B. General: Cartridge-type assemblies suitable for potable water. Include housing, fittings, filter cartridges, and cartridge end caps.

C. Wall-Mounting Type: Housing head section with threaded inlet and outlet, mounting bracket, and removable lower section for 10-inch- (250-mm-) long filter cartridge.

1. Housing Material: Stainless steel, 150-psig (1035-kPa) Plastic, 125-psig (860-kPa) minimum operating pressure.

2. Cartridge: Manufacturer Standard filter media, 10 inches (250 mm), 10-micron-particulate removable rating.

D. Floor-Mounting Type: Stainless-steel housing rated at 150-psig (1035-kPa) minimum operating pressure.

1. Base Section: Floor-mounting section with inlet and outlet connections and removable top section for one or more 10-micron-particulate, removable-rating cartridges.

2. Connections, NPS 2 (DN 50) and Smaller: Threaded.

3. Connections, NPS 2-1/2 (DN 65) and Larger: Flanged.

4. Cartridges: Manufacturer Standard filter media.

2.25 STEEL, PRECHARGED, WATER STORAGE TANKS

A. Steel, Precharged, Diaphragm, Water Storage Tanks:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. AMTROL, Inc.

b. Armstrong Pumps, Inc.

c. Flexcon Industries; Plumbing & Heating Division.

d. Flo Fab Inc.

e. Myers; Pentair Pump Group.

f. State Industries, Inc.

g. Taco, Inc.

h. Wessels Company.

2. Description: Steel, vertical, pressured-rated tank with cylindrical sidewalls and with air-charging valve and air precharge.

3. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

4. Operation: Factory-installed, butyl-rubber diaphragm.

B. Steel, Precharged, Bladder, Water Storage Tanks:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Armstrong Pumps, Inc.

b. Taco, Inc.

c. Wessels Company.

d. Wood, John Co.

2. Description: Steel, vertical, pressured-rated tank with cylindrical sidewalls and with air-charging valve and air precharge.

3. Fabricate supports and attachments to tank with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure.

4. Operation: Factory-installed, butyl-rubber bladder.

C. Construction: ASME code, steel, constructed with nontoxic welded joints, for 125-psig (860-kPa) 150-psig (1035-kPa) working pressure.

D. Tappings: Factory-fabricated stainless steel, welded to tank before testing and labeling.

1. NPS 2 (DN 50) and Smaller: ASME B1.20.1, with female thread.

2. NPS 2-1/2 (DN 65) and Larger: ASME B16.5, flanged.

E. Specialties and Accessories: Include tappings in tank and the following:

1. Pressure gage.

2. Shut Off Valve

F. Vertical Tank Supports: Factory-fabricated steel legs or steel skirt, welded to tank before testing and labeling.

G. Tank Interior Finish: Materials and thicknesses complying with NSF 61 barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

1. Coating: Epoxy resin Galvanized Glass or Nickel.

H. Exterior Coating: Manufacturer's standard enamel paint.

PART 3 - EXECUTION

3.1 DEVICES INSTALLATION

A. Install secondary backflow preventers in each water supply connection to mechanical, and kitchen, equipment, systems, appliances and to other equipment and water systems that may be sources of contamination and as required by local codes. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system, unless equipment (cooling tower) is in un-heated space.

2. Install drain for backflow preventers with atmospheric-vent drain connection with fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate fixed air-gap device attached to backflow preventer. Simple air breaks are unacceptable for this application.

3. Do not install bypass piping around backflow preventers.

4. Install vacuum breakers at least 12" above highest point of water use.

5. Do not install copper tubing between backflow preventer and carbonated beverage dispenser.

B. Install water pressure regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet of each regulator.

C. Install all types of water-control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.

D. Install balancing valves in locations where they can easily be adjusted.

E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

F. Install pre-manufactured cabinet-type units recessed in or surface mounted on wall or ceiling as specified.

G. Install Y-pattern strainers for water on supply side of each control valve water pressure-reducing valve solenoid valve water heater and filter.

H. Install outlet boxes recessed in wall or surface mounted on wall. Install wall reinforcement between studs.

I. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.

J. Install pre-manufactured cabinet-type units recessed in or surface mounted on wall as specified. Install wall reinforcement between studs.

K. Install ground hydrants with 1 cu. yd. (0.75 cu. m) of crushed gravel around drain hole. Set ground hydrants with box flush with grade.

L. Install draining-type post hydrants with 1 cu. yd. (0.75 cu. m) of crushed gravel around drain hole. Set post hydrants in concrete paving or in 1 cu. ft. (0.03 cu. m) of concrete block at grade. Provide drain valve, drain piping, spill indirectly over nearest floor drain or janitors sink.

M. Set nonfreeze, nondraining-type post hydrants in concrete or pavement.

N. Set freeze-resistant yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.

O. Provide "non-potable water" warning signs for all hydrants supplied of recycled water systems.

P. Install water meters and their accessories in accordance to are latest edition of Utility water company regulations.

Q. Install air vents at high points of water piping unless high point is active water supply connection. Install drain tubing at relief valve discharge port and spill onto floor drain via air gap.

R. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

S. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

T. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

U. Install main pressure reducing valves assemblies as per detail on the drawings.

V. Install pressure sustaining valves on the high demand branches.

W. Provide water hammer arresters (shock absorbers) where required and immediately adjacent to all pieces of equipment wherein quick closing valves including: single lever shower valves and flush valves are installed, including all equipment with solenoid valves such as but not limited to laundry washers, dish washers, pot washers, cooling tower make-up, etc. Install water hammer arresters between last two fixtures served, if branch piping is less than 20 feet long. For piping longer than 20 feet, size and locate shock absorbers shall be as recommended by the manufacturer whose product is used. The system shall be tested prior to the walls closing, to ensure no water hammer occurs in it.

X. Install check valves upstream of every water filter to prevent filter housing rupture in case of vacuum in the system.

3.2 TANKS INSTALLATION

A. Install vertical water storage tanks on minimum 4” high concrete bases, or dunnage level and plumb, firmly anchored. Arrange so devices needing servicing are accessible. Install horizontal tanks on concrete piers and factory-fabricated or fabricated steel supports and saddles.

B. Anchor tank supports and tanks to substrate. Use steel or FRP straps over or around plastic tanks.

C. Install tank seismic restraints.

D. Install thermometers and pressure gages on water storage tanks and piping. Thermometers and pressure gages are specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

E. Install the following devices on tanks:

1. Temperature and pressure relief valves.

2. Vacuum relief valves.

3. Tank vents and overflows on nonpressure tanks.

4. Connections to accessories.

F. After installing tanks with factory finish, inspect finishes and repair damages to finishes.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to water storage tanks to allow service and maintenance.

C. Connect water piping to water storage tanks with unions or flanges and with shutoff valves. Connect tank drains with shutoff valves and discharge over closest floor drains.

1. Water Piping Connections: Make connections to dissimilar metals with dielectric fittings. Dielectric fittings are specified in Section 22 11 16 "Domestic Water Piping."

3.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or permanent sign on or near each of the following:

1. Pressure vacuum breakers.

2. All backflow preventers.

3. Water pressure-reducing and pressure-sustaining valves.

4. Balancing valves.

5. Thermostatic water mixing valves.

6. Hose stations.

7. Trap-seal primer valves.

8. Water hammer arresters.

9. Tanks.

10. Visible manufacturer’s logo is not permitted in public areas.

11. Include date of installation on all nameplates.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test each pressure vacuum breaker backflow preventer and meter according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing and pressure-sustaining valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

3.7 CLEANING

A. Clean and disinfect water storage tanks.

B. Use purging and disinfecting procedure for potable water tanks prescribed by authorities having jurisdiction or, if method is not prescribed, use procedure described in AWWA C652 or as described below:

1. Purge water storage tanks with potable water.

2. Disinfect tanks by one of the following methods:

a. Fill tanks with water-chlorine solution containing at least 50 ppm (50 mg/L) of chlorine. Isolate tanks and allow to stand for 24 hours.

b. Fill tanks with water-chlorine solution containing at least 200 ppm (200 mg/L) of chlorine. Isolate tanks and allow to stand for three hours.

3. Flush tanks, after required standing time, with clean, potable water until chlorine is not present in water coming from tank.

4. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination made by authorities having jurisdiction shows evidence of contamination.

C. Prepare written reports for purging and disinfecting activities.

END OF SECTION 22 11 19

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SECTION 22 13 16 – STORM AND SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.

2. Specialty pipe fittings.

3. Encasement for underground metal piping.

B. Related Sections:

1. Section 22 13 19 “Sanitary Waste and Storm Piping Specialties”.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. LLDPE: Linear, low-density polyethylene plastic.

D. NBR: Acrylonitrile-butadiene rubber.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

G. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Gravity Piping: 10-foot head of water (30 kPa).

2. Force-Main Piping: 50 psig (345 kPa).

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, couplings, hangers, supports, hardware, inserts, etc.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and primers, documentation including printed statement of VOC content.

2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

1.6 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control inspections and test reports.

1.7 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp or other markings of specified testing agency.

B. All cast iron soil pipe and fittings shall be marked with the trademark of the Cast Iron Soil Pipe Institute (CISPI).

C. Installer – Company specializing in plumbing systems with 7 (seven) years minimum experience.

D. All cast iron pipe and fittings shall meet the CISPI 301 or ASTM A-888 quality standard and shall be listed and certified by IAPMO, ISS and NSF.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Sewers, and drains: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Architect Construction Manager and Owner no fewer than two days in advance of proposed interruption of sewer.

2. Do not proceed with interruption of sewer without Architect's Construction Manager's and Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article and schedule on the drawings for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. This contractor will be required to submit a list for approval for all piping to be used, manufacturers name and pressure ratings for all systems.

C. Listed below are references to the specification standards of recognized authorities to which pipe and fitting materials must conform to be acceptable. All reference shall be the latest edition in force at the time of bidding.

D. Materials indicated are subject to approval of local governing authorities.

E. Each pipe length shall have the manufacturer's name, country of origin, date, pipe diameter and relevant testing agency stamp the information shall be permanently cast, stamped or rolled on.

F. Each fitting shall have the manufacturer's symbol and pressure rating cast, stamped or rolled on, and shall be pressure rated and suitable for the respective system.

G. Material Test Reports: Suppliers of cast iron soil pipe shall be able to supply material tests reports in accordance with the relevant ASTM standard and shall include testing and analysis on: radioactivity, dimensional characteristics, tensile strength and chemical/metallurgical content. Suppliers shall also supply MSDS sheets on all coatings.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service or Extra Heavy class.

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: CISPI 301 or ASTMA A-888.

B. CISPI 310 or ASTMA A-888, Standard Duty Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide one of the following:

a. ANACO.
b. Mission Rubber Company

c. Ideal.
d. Tyler Coupling.

2. Standards: ASTM C 1277 ASTM C1540 and CISPI 310. Standard duty couplings shall be certified by NSF International and shall have the NSF Mark on each coupling

3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. ASTM C1540 Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide one of the following:

a. ANACO.
b. Clamp-All Corp.
c. Mission Rubber Company
d. Ideal.
e. Tyler Coupling.

2. Standards: ASTM C 1540.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.

B. Galvanized Cast-Iron Drainage Fittings: ASME B16.12, threaded.

C. Steel Pipe Pressure Fittings:

1. Galvanized Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.

2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.

3. Galvanized Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. Cast-Iron Flanges: ASME B16.1, Class 125.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

E. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, provide one of the following:

a. Anvil International.
b. Grinnell Mechanical Products.
c. Victaulic Company.
d. Ward Manufacturing.
e. Star Pipe Products.

2. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 536 ductile-iron castings, ASTM A 47/A 47M malleable-iron castings, ASTM A 234/A 234M forged steel fittings, or ASTM A 106/A 106M steel pipes with dimensions matching ASTM A 53/A 53M steel pipe, and complying with AWWA C606 for grooved ends.

3. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

2.5 STAINLESS-STEEL PIPE AND FITTINGS

A. Pipe and Fittings: ASME A112.3.1, drainage pattern with socket and spigot ends.

B. Internal Sealing Rings: EPDM Elastomeric gaskets shaped to fit socket groove with plastic back-up ring NBR gaskets where indicated.

2.6 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.

3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron, Push-on-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.

3. Gaskets: AWWA C111/A21.11, rubber.

C. Ductile-Iron, Grooved-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51 with round-cut-grooved ends according to AWWA C606.

2. Ductile-Iron-Pipe Appurtenances:

a. Manufacturers: Subject to compliance with requirements, provide one of the following:

(i) Anvil International.
(ii) Star Pipe Products.
(iii) Victaulic Company.

b. Grooved-End, Ductile-Iron Fittings: ASTM A 536 ductile-iron castings with dimensions matching AWWA C110/A 21.10 ductile-iron pipe or AWWA C153/A 21.53 ductile-iron fittings and complying with AWWA C606 for grooved ends.
c. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.7 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.

2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

3. Unshielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

(i) Dallas Specialty & Mfg. Co.
(ii) Fernco Inc.
(iii) Mission Rubber Company.
(iv) NDS, Inc.
(v) Logan Clay Products Company.

b. Standard: ASTM C 1173.
c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

d. Sleeve Materials:

(i) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
(ii) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

(i) Cascade Waterworks Mfg. Co.
(ii) Mission Rubber Company; a division of MCP Industries, Inc.

b. Standard: ASTM C 1460.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Pressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

(i) Cascade Waterworks Mfg. Co.
(ii) Dresser, Inc.
(iii) EBAA Iron, Inc.
(iv) JCM Industries, Inc.
(v) Romac Industries, Inc.
(vi) Smith-Blair, Inc.
(vii) The Ford Meter Box Company, Inc.
(viii) Viking Johnson.

b. Standard: AWWA C219.
c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
d. Center-Sleeve Material: Manufacturer's standard Carbon steel Stainless steel Ductile iron or Malleable iron.
e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2. Dielectric Unions:

   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

      (i) Watts Regulator Co.
      (ii) Wilkins.
      (iii) EPCO.

   b. Description:

      (i) Standard: ASSE 1079.
      (ii) Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
      (iii) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

      (i) Watts Regulator Co. .
      (ii) Wilkins; a Zurn company.
      (iii) EPCO.

   b. Description:

      (i) Standard: ASSE 1079.
      (ii) Factory-fabricated, bolted, companion-flange assembly.
      (iii) Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
      (iv) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

      (i) Advance Products & Systems, Inc.
      (ii) Calpico, Inc.
      (iii) Central Plastics Company.
      (iv) Pipeline Seal and Insulator, Inc.
      (v) EPCO.

   b. Description:

      (i) Nonconducting materials for field assembly of companion flanges.

(ii) Pressure Rating: 150 psig (1035 kPa).
(iii) Gasket: Neoprene or phenolic.
(iv) Bolt Sleeves: Phenolic or polyethylene.
(v) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

(i) Elster Perfection.
(ii) Grinnell Mechanical Products.
(iii) Matco-Norca, Inc.
(iv) Precision Plumbing Products, Inc.
(v) Victaulic Company.

b. Description:

(i) Standard: IAPMO PS 66
(ii) Electroplated steel nipple complying with ASTM F1545
(iii) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
(iv) End Connections: Male threaded or grooved.
(v) Lining: Inert and noncorrosive, propylene.

6. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.

a. Manufacturer:

(i) Metraflex
(ii) Red Valve

7. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

a. Manufacturers:

(i) Red Valve
(ii) Metraflex
(iii) Flexicraft

8. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

a. Manufacturer:

(i) SIGMA Corp.

2.8 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105/A 21.5.

B. Material: Linear low-density polyethylene film of 0.008-inch (0.20-mm) or high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm) minimum thickness.

C. Form: Sheet.

D. Color: Black.

PART 3 - EXECUTION

3.1 LAYING OF PIPE IN GROUND

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

B. Lay and maintain required grade and lines, all bells or hubs upgrade.

C. Sleeve piping passing through masonry walls and rigid structures provide minimum one inch clearance around pipe to permit caulking. Caulk watertight.

D. Inspect each pipe length and fitting for defects before placing in trench, remove defective pieces from site.

E. Do not drop or dump; carefully lower pipe and fittings into place.

F. Trenches shall be kept free of water until all pipe joints are made and jointing material has set.

G. Do not lay pipe on frozen trench bottom unless specifically approved by Architect.

H. Keep lines free of foreign material and open ends covered when work is not in progress.

I. Take precautions as required to prevent empty pipe from floating. Remove any floated pipe from trench and properly relay.

J. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

K. Install underground cast iron piping in accordance with Cast Iron Soil Pipe Handbook as published by CISPI.

L. Encase piping in PE Film where soil is corrosive or where indicated on the drawings.

M. Piping buried in concrete shall not touch rebars.

3.2 PIPING INSTALLATION WITHIN THE BUILDING ABOVE SLAB

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. All pipes passing through roofs shall be provided with an extra heavy cast iron flashing fittings, set at a suitable level above roof to terminate the flashing to be installed by another trade. Any piping passing through roofs shall be so arranged to be a minimum of 12" from walls or other obstructions so as to permit proper flashing.

G. Install vent through roof terminals minimum ten feet away from any air intakes or building openings. Terminate minimum 24” above finished roof or 7’-0” if the roof is used for other than weather protection.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping and hangers to allow application of insulation, where required.

K. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Install drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Drains: 1 percent downward in direction of flow.

2. Horizontal Drainage Piping NPS 2” (DN 50) and smaller: 2 percent NPS 3" (DN 80) and larger 1 percent downward in direction of flow.

3. Vent Piping: 0.5 percent down toward vertical fixture vent or up toward vent stack for proper condensate drainage.

4. Piping to be installed at slopes more than minimum, if indicated on the drawings.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings." or manufacturers recommendations.

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

N. Install steel piping according to applicable plumbing code.

O. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

P. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

Q. Install force mains at elevations indicated, provide pressure type cleanouts. Slope force mains to the drain points at minimum 1 percent slope.

R. Plumbing Specialties:

1. Install backwater valves in gravity-flow piping and house sewer. Comply with requirements for backwater valves specified in Section 22 13 19 "Sanitary and Storm Waste Piping Specialties." Back water valves are required for all buildings located on flood zones.

2. Install cleanouts at grade and extend to where building drains connect to building sewers in drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in drainage force-main piping. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary and Storm Waste Piping Specialties."

3. Install drains in drainage gravity-flow piping. Comply with requirements for drains specified in Section 22 13 19 "Sanitary and Storm Waste Piping Specialties."

S. Do not enclose, cover, or put piping into operation until it is tested, inspected and approved by authorities having jurisdiction.

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" or manufacturer's recommendation for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" or manufacturer's recommendation for hubless-piping coupling joints.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.

E. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

F. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.

2. In Drainage Piping: Unshielded Shielded, nonpressure transition couplings.

3. In Aboveground Force Main Piping: Fitting-type transition couplings.

4. In Underground Force Main Piping:

a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples and/or unions.

3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges, flange kits or nipples.

4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

C. Flexible connectors – install on sanitary vent piping when crossing building seismic or expansion joints. Drainage piping shall not cross expansion joints.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping" and Section 22 13 19 “Sanitary and Storm Waste Piping Specialties.”

B. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves.

2. House Sewer: At the building wall.

3. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.

4. Install backwater valves in accessible locations.

5. Comply with requirements for backwater valve specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install galvanized carbon-steel pipe hangers for horizontal piping in noncorrosive environments.

2. Install stainless-steel pipe hangers for piping in corrosive environments.

3. Install galvanized carbon-steel pipe support clamps for vertical piping in noncorrosive environments.

4. Vertical Piping: MSS Type 8 or Type 42, clamps.

5. Install individual, straight, horizontal piping runs:

   a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet (30 m) if indicated: MSS Type 49, spring cushion rolls.

6. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

7. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting valve and coupling. Each pipe segment between two couplings or hubs shall have at least one support.

C. Support all vertical piping and tubing at base and at each floor and between floors, if floor to floor distance exceed maximum distance between supports required by the code.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

E. Unless otherwise indicated in the code or manufacturer's recommendations, install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.

2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.

3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.

4. NPS 6 and NPS 8 (DN 150 and DN 200): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.

5. NPS 10 and NPS 12 (DN 250 and DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.

6. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).

7. Each pipe segment between two couplings shall have an individual hanger, regardless of segment length.

F. Unless otherwise indicated in the code, install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.

2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.

3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.

4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.

5. NPS 3 (DN 80): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.

6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.

7. NPS 6 and NPS 8 (DN 150 and DN 200): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.

8. NPS 10 and NPS 12 (DN 250 and DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

G. Unless otherwise indicated in the code, install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.

2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.

3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.

4. NPS 3 and NPS 5 (DN 80 and DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.

5. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.

6. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect house drains to house sewers. Use transition fitting to join dissimilar piping materials.

C. Connect piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code. Water closets connection shall be 4 inch (100 mm).

2. Lavatory connection shall be 2 inch (50 mm), if the lavatory does not have an overflow.

3. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

4. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

5. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.

6. Comply with requirements for backwater valves cleanouts and drains specified in Section 22 13 19 "Sanitary and Storm Waste Piping Specialties."

7. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

8. Connect storm drainage piping to roof drains and storm drainage specialties.

D. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed and concealed piping. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil, sanitary waste and vent piping any size shall be the following:

1. Service class, hub-and-spigot cast-iron soil pipe and fittings.

2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints. Standard couplings permitted for Horizontal vent Branches up to 3” size.

3. Galvanized-steel pipe, drainage fittings, and threaded joints.

4. Stainless-steel pipe and fittings, sealing rings, and gasketed joints.

5. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Aboveground storm drainage piping any size shall be the following:

1. Service class, hub-and-spigot cast-iron soil pipe and fittings.

2. Ductile iron piping with mechanical, push-on or grooved joint, hubless-piping couplings; and coupled joints.

3. Dissimilar Pipe-Material Couplings: Unshielded Shielded, nonpressure transition couplings.

D. Underground storm soil, waste, and vent piping any size shall be the following:

1. Extra Heavy or Service class, cast-iron soil piping; and calked joints.

2. Ductile iron piping with mechanical, push-on or grooved joints.

3. Stainless-steel pipe and fittings, gaskets, and gasketed joints.

4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

3.12 DRIP PANS:

A. Examine the drawings and in cooperation with the Electrical Trade confirm the final location of all electrical equipment to be installed in the vicinity of piping. Plan and arrange all overhead piping no closer than two feet from a vertical line to electric motors and controllers, switchboards, panelboards, or similar equipment. Piping is not permitted in Electric Equipment, Transformer, Switch Gear, and Telephone Gear Rooms.

B. Where the installation of piping does not comply with the requirements of foregoing paragraph, where feasible the piping shall be relocated.

C. Provide drip pans with leak detectors for drainage piping whether exposed or above ceilings in operating and delivery rooms, nurseries, food preparation and storage areas, kitchens or other sensitive areas.

D. Furnish gutters as follows:

1. Provide and erect a gutter of 16 ounce cold rolled copper or 18 gauge galvanized steel, under every pipe which is within 2'-0" from a vertical line to any motor, electrical controllers, switchboards, panelboards, or the like.

2. Each gutter shall be reinforced, rimmed, soldered and made watertight, properly suspended and carefully pitched to a convenient point for draining. Provide a 3/4" drain, with valve as directed, to nearest floor drain or slop sink, as approved.

3. In lieu of such separate gutters, a continuous protecting sheet of similar construction adequately supported and braced, properly rimmed, pitched and drained, may be provided over any such motor, and extending 2'-0" in all directions beyond the motor, over which such piping has to run.

END OF SECTION 22 13 16

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SECTION 22 13 19 - SANITARY WASTE AND STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Backwater valves.
2. Cleanouts.
3. Floor drains.
4. Roof, open areas and Terrace Drains.
5. Trench drains.
6. Channel drainage systems.
7. Air-admittance valves.
8. Washing machine wall box.
9. Roof flashing assemblies.
10. Through-penetration firestop assemblies.
11. Miscellaneous sanitary and storm drainage piping specialties.
12. Flashing materials.
13. Grease interceptors, except grease interceptors installed outside of the building or under building slab.
14. Prefabricated Solids interceptors.

B. Related Requirements:

1. Section 22 13 23 “Waste Interceptors” for precast concrete, plastic or steel interceptors installed outside of the building or within the building in-ground.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. (C) PVC: (Clorinated) Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:

1. FOG disposal systems.

2. Grease interceptors.

3. Grease removal devices.

4. Oil interceptors.

B. Shop Drawings:

1. Show fabrication and installation details for frost-resistant vent terminals.

2. Wiring Diagrams: Power, signal, and control wiring for all specialties that require power.

1.5 INFORMATIONAL SUBMITTALS

A. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

B. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.8 COORDINATION

A. Coordinate size and location of concrete bases, slab openings and pits. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 03 30 00 "Cast-in-Place Concrete" and Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."

B. Coordinate size and location of roof; deck and shear walls penetrations.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cultures: Provide 1-gal. bottles of bacteria culture recommended by manufacturer of FOG disposal systems equal to 200 percent of amount installed, but no fewer than 2 1-gal. bottles.

PART 2 - PRODUCTS

2.1 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Josam Company.
b. MIFAB, Inc.
c. Wade
d. Watts Drainage Products Inc.
e. Zurn Plumbing Products Group.
f. Tideflex
g. Claval

2. Standard: ASME A112.14.1.

3. Size: Same as connected piping.

4. Body: Cast iron.

5. Cover: Cast iron with bolted or threaded access check valve.

6. End Connections: Hub and spigot or hubless match the pipe.

7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition or elastomer check sleeve.

8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves :

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Josam Company.
   b. Watts Drainage Products Inc.
   c. Zurn Plumbing Products Group.
   d. MIFAB Inc.
   e. Wade
   f. Tideflex
   g. Claval

2. Size: Same as floor drain outlet.

3. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.

4. Check Valve: Removable ball float Drain Strainer

5. Inlet: Match the Pipe

6. Outlet: Spigot

2.2 CLEANOUTS

A. General

1. Provide cleanouts at the base of all soil, waste and storm water leaders and at all changes in direction on horizontal piping. Distance between cleanouts on horizontal runs shall be made accessible by means of approved deck plates, access covers and doors.

2. Cleanouts in vertical stacks shall consist of tapped tees capable of receiving a rough brass raised head cleanout plug.

3. Access doors and frames for cleanouts located behind walls will be furnished by the Plumbing Trade and installed under another section of the work. A complete list of wall cleanout locations shall be furnished to the installing contractor prior to erection of walls.

4. Where cleanouts occur in floors they shall be compatible with the surrounding finished surface.

5. All cleanout plugs shall be lubricated with graphite before installation.

6. Cleanouts occurring in cast iron soil pipe above floor at change in direction of pipe run and at ends of horizontal runs shall be with cast iron ferrule for caulk connection and fitted with a straight threaded, tapered bronze plug with raised hex head.

7. All cleanout plugs shall be up with graphite and oil to facilitate easy removal. No pipe compound is to be used on plugs.

8. Cleanouts shall be provided with adjustable clamping collar devices where flashing and/or waterproof floor and slabs occur.

B. Metal Cleanouts:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Josam Company.
   b. Sioux Chief Manufacturing Company, Inc.
   c. Wade.
   d. Watts Drainage Products Inc.
   e. Zurn Plumbing Products Group.

2. Size: Same as drain pipe, up to 6" maximum for pipes 8" and larger.

3. Type: Adjustable housing.

4. Body or Ferrule: Cast iron or Stainless steel.

5. Adjustable Housing Material: Cast iron stainless steel with threads set-screws or other device.

6. Frame and Cover Material and Finish: Nickel-bronze, copper alloy Painted cast iron Polished bronze Rough bronze or Stainless steel.

7. Frame and Cover Shape: Round.

8. Top Loading Classification: Extra Heavy Heavy or Medium Duty as requested per location.

9. Riser: ASTM A 74, Extra-Heavy or Service class, cast-iron stainless steel drainage pipe fitting and riser to cleanout.

10. Masonry Access: Round, deep, chrome-plated bronze or flat, chrome-plated brass or stainless-steel cover plate with screw.

11. Drywall Access: Round or Square, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.3 DRAINS

A. General

1. This paragraph applies to all floor and roof drains.

2. The drain schedule on the drawings indicates the particular drain desired at the various locations indicated. The drains selected are representative of the quality, design and finish desired. Drains of other manufacturers may be submitted provided they meet fully in every respect (such as materials, weight open areas, clamping features, grate surface and finish, etc.) the characteristics and quality of the drain specified.

3. All drains shall include adjustable clamping device where membrane, flashing, or other waterproof floors or decks occur.

4. All drains shall include suitable extension collars, sump receivers, under deck clamps, as required to suit roof, floor or deck construction.

5. On all areas requiring flashing, provide flashing extending at least 12" beyond drainage flange and connections made water tight.

B. Metal Floor Drains Cast Iron or Stainless Steel:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Josam Company.
b. MIFAB, Inc.
c. Wade.
d. Watts Drainage Products Inc.
e. Zurn Plumbing Products Group.

2. Standard: ASME A112.6.3 cast iron; and ASME A 112.3.1, 112.6.3 Stainless Steel.

3. Pattern: Area Floor Funnel floor or Funnel drain.

4. Body Material: Cast iron Stainless Steel.

5. Integral Backwater Valve: Where indicated.

6. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel must be used for kitchen, laboratory, laundry and pool equipment room drains. Standard factory coating for all other locations.

7. Top Shape: Round.

8. Top Loading Classification: Extra Heavy-Duty Heavy Duty or Medium Duty Suitable for location.

2.4 CONCRETE TRENCH DRAIN GRATES

A. Trench Drains:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Josam Company.
b. MIFAB, Inc.
c. Wade.
d. Watts Drainage Products Inc.
e. Zurn Plumbing Products Group.

2. Standard: ASME A112.6.3 for trench drains.

3. Flange: as required.

4. Grate Material: Ductile iron Ductile iron or gray iron.

5. Grate Finish: Painted or Galvanized All grates in areas accessible by general public shall be heel-proof.

6. Top Loading Classification: Extra Heavy-Duty Heavy Duty Medium Duty suitable for location.

2.5 CHANNEL DRAINAGE SYSTEMS

A. Stainless-Steel Channel Drainage Systems:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Josam Company.
b. Zurn Plumbing Products Group.
c. ACO Drain.
d. Gatic

2. Type: Modular system of stainless-steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.

a. Standard: ASME A112.3.1, for trench drains.
b. Channel Sections: Interlocking-joint, stainless-steel with level invert.

c. Grates: Manufacturer's designation “Extra heavy heavy medium duty," with heel proof slots or perforations, and of width and thickness that fit recesses in channels.

1) Material: Ductile iron Fiberglass Galvanized steel Gray iron or Stainless steel.
2) Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.

d. Covers: Solid ductile or gray or galvanized iron, of width and thickness that fit recesses in channels, and of lengths indicated.
e. Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
f. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.6 ROOF DRAINS

A. Cast-Iron, General-Purpose Main Roof Cornice Gutter Terrace Area or Deck Drains:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Josam Company.
b. MIFAB, Inc.
c. Wade.
d. Watts Water Technologies, Inc.
e. Zurn Plumbing Products Group.

2. Standard: ASME A112.6.4, for general-purpose roof drains.

3. Body Material: Cast iron.

4. Combination Flashing Ring and Gravel Stop: Install where indicated.

5. Flow-Control Weirs: For controlled flow drains.

6. Dome Material: Aluminum Cast iron or Stainless steel.

7. Perforated Gravel Guard; where required Stainless steel.

8. Water Dam: Where required 2 inches high.

2.7 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Adaptors:

1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.

2. Size: Inlet size to match parapet drain outlet.

B. Downspout Boots:

1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; and shop-applied bituminous coating.

2. Size: Inlet size to match downspout.

C. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.

2. Size: Same as connected conductor.

2.8 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Sioux Chief
b. Durgo, Inc.
c. Oatey.
d. ProSet Systems Inc.
e. RectorSeal.
f. Studor, Inc.

2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.

3. Operation: Mechanical sealing diaphragm.

4. Size: Same as connected fixture or branch vent piping.

B. Stack Air-Admittance Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Durgo, Inc.
b. Oatey.
c. Studor, Inc.
d. Sioux Chief

2. Standard: ASSE 1050 for vent stacks.

3. Operation: Mechanical sealing diaphragm.

4. Size: Same as connected stack vent or vent stack.

C. Washing Machine Wall Box:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Symmons.
b. Oatey.
c. RectorSeal.
d. Studor, Inc.

2. Description: White metal housing with white metal grille, made for recessed installation. Include bottom pipe connection and water shut-off valves.

2.9 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies :

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Acorn Engineering Company; Elmdor/Stoneman Div.
b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch-thick, lead flashing collar and skirt extending at least 6 inches, but not less than pipe diameter. from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

1. Open-Top Vent Cap: Without cap.

2. Low-Silhouette Vent Cap: With vandal-proof vent cap.

3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.10 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ProSet Systems Inc.

b. Hilti.

2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.

3. Size: Same as connected soil, waste, or vent stack.

4. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.

5. Special Coating: Corrosion resistant on interior of fittings.

2.11 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains :

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.

2. Size: Same as connected waste piping with increaser funnel of size indicated or with fixed air gap fitting.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.

2. Size: Same as connected waste piping.

a. NPS 2: 4-inch-minimum water seal.
b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.

2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Fixed Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.

2. Body: Bronze or galvanized cast iron.

3. Inlet: Opening in top of body.

4. Outlet: Larger than inlet.

5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.

2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.

2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.

2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints:

1. Standard: ASME A112.21.2M.

2. Body: Cast iron with bronze sleeve, packing, and gland.

3. End Connections: Matching connected piping.

4. Size: Same as connected vent piping. Note: Do not use on drain piping, which should not have expansion joints.

2.12 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft..

2. Vent Pipe Flashing: 8 oz./sq. ft..

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.13 GREASE INTERCEPTORS

A. Grease Interceptors:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Applied Chemical Technology, Incorporated.
b. Josam Company.
c. MIFAB, Inc.
d. Rockford Sanitary Systems, Inc.
e. Wade.
f. Watts Drainage Products Inc.
g. Zurn Plumbing Products Group.
h. Green Turtle.

2. Standard: ASME A112.14.3 and PDI-G101, for intercepting and retaining fats, oils, and greases from food-preparation or -processing wastewater.

3. Plumbing and Drainage Institute Seal: Required.

4. Body Material: Cast iron Cast iron or steel or Stainless steel.

5. Interior Lining: Corrosion-resistant enamel Not required for stainless steel.

6. Exterior Coating: Corrosion-resistant enamel.

7. Body Dimensions: See drawings.

8. Body Extension: Provide where required.

9. Grease Retention Capacity: See drawings.

10. Inlet and Outlet Size: See drawings.

11. Cleanout: Integral or field installed on outlet.

12. Mounting: Above floor Recessed in acid-resistant, coated steel frame and cradle or Recessed, flush with floor.

13. Flow-Control Fitting: Required.

14. Operation: Manual cleaning.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment Mounting: Install interceptors and removal devices on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases specified in Section 03 30 00 "Cast-in-Place Concrete" and Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."

1. Coordinate sizes and locations of concrete bases with actual equipment provided.

2. Construct concrete bases 6 inches high and extend base not less than 6 inches in all directions beyond the maximum dimensions of specified equipment, unless otherwise indicated or unless required for seismic anchor support.

3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.

5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

6. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Install backwater valves in building drain piping and house sewer. Provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

C. Install cleanouts in aboveground piping and building drain piping according to the Plumbing Code Requirements: Coordinate with building structure, HVAC trade and other building system to make sure access clearance is provided in front of cleanout as required by code.

D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor or carpet markers where required.

E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance, not obstructed by equipment and concrete pads.

2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the Architectural drawings:

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

G. Assemble and install ASME A112.3.1, channel drainage systems according to ASME A112.3.1. Install on support devices so that top will be flush with surface.

H. Assemble non-ASME A112.3.1, channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

I. Install fixture air-admittance valves on fixture drain piping.

J. Install stack air-admittance valves at top of stack vent and vent stack piping.

K. Install air-admittance-valve wall boxes recessed in wall.

L. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. The extension lengths shall be at least 6” above roofs not used for public access and at least 7’-0” above roofs used for public access – unless otherwise indicated in the code.

M. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

N. Install through-penetration firestop assemblies at floor penetrations.

O. Assemble open drain fittings and install with top of hub funnel or fixed air gap above floor.

P. Install deep-seal traps on floor drains and other waste outlets, if indicated.

Q. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.

2. Size: Same as floor drain inlet.

R. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

S. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

T. Install expansion joints on vent piping crossing building expansion joint. Position expansion joints for easy access and maintenance.

U. Install interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.

1. Above-Floor Installation: Set unit with bottom resting on elevated concrete pad, unless otherwise indicated.

2. Flush with Floor Installation: Set unit and extension, with cover flush with finished floor. Cover bolts heads shall be recessed flush with floor level; bolt heads above floor level are not acceptable.

3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.

4. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

V. Install grease removal devices on floor. Install trap, vent, and flow-control fitting according to authorities having jurisdiction. Install control panel adjacent to unit, unless otherwise indicated.

W. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

X. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 ROOF DRAINS INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.

1. Install flashing collar or flange or roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.

2. Install expansion joints, if indicated, in roof drains outlets.

3. Position roof drains for easy access and maintenance.

B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install downspout boots at grade with top 12 inches (305 mm) above grade. Secure to building wall. Provide concrete splash blocks on the roof.

D. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

3.3 CONNECTIONS

A. Comply with requirements in Section 22 13 16 "Storm and Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Interceptors: Connect inlet and outlet to unit, and connect flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic drawoff-type unit.

D. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.

2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.

3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 07 62 00 "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.5 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Grease interceptors.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.7 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19

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SECTION 22 32 00 - DOMESTIC WATER FILTRATION EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Screen filters.

B. Related Sections:

1. Division 22 Section 22 05 00 “Common Work Results for Plumbing”.

2. Section 22 11 19 "Domestic Water Piping Specialties" for plumbing piping strainers and for small cartridge-type water filters.

3. This Section is a part of each Division 22.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for filters. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For water filtration equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates of Shop Inspections and Data Reports: For products required to have ASME label, signed by product manufacturer.

B. Welding certificates.

C. Source quality-control reports.

D. Field quality-control reports.

E. Startup service test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water filtration equipment to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of water filtration equipment through one source from a single manufacturer.

B. Welding Qualifications: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NSF 61, "Drinking Water System Components - Health Effects," for all components that will be in contact with potable water.

1.7 COORDINATION

A. Coordinate size and location of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 AUTOMATIC SCREEN FILTERS, ELECTRIC:

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Omicron Water Technologies (www.omicronwater.com)

2. Basis-of-Design Product: Subject to compliance with requirements, provide Omicron 3500-25(V) PN10 316L or comparable product that meets specifications.

3. Description: Factory-fabricated and -tested, simplex, 316L stainless steel housing with weave wire screen rated at 18 micron and accordingly providing near total reduction of total suspended solids (TSS) above 18 microns, and additional reduction of TSS smaller than 10 microns as is characteristic of screen filtration technology in municipal water conditions. With 6-inch inlet and outlet, raised face flange connections pressure rated to meet the system requirements.

4. Operation Description: The water flows into the filter body and through the stainless steel coarse filter element outside in, keeping large debris from entering the fine screen. Once water flows through the coarse screen, the water enters the stainless steel fine filter element inside out, allowing the dirt to accumulate on the inside surface of the element. A Differential Pressure Switch (DPS) senses the pressure differential across the filter as filter cake builds up on the element. The DPS shall signal the PLC control panel to initiate the cleaning cycle of the filter when the filter cake causes a pressure differential of 0.3 bar (4.4 psi), visible on the PD display. PD set point shall be user adjustable via the HMI touchscreen. During the flushing cycle, there shall be no interruption of flow. With a clean screen at the maximum flow rate, the filter shall lose less than 1 psi. The filter operation and flushing shall be controlled and monitored by a touchscreen PLC control panel. The panel, and its related circuitry, shall be housed in a NEMA 4X-rated enclosure. A single point power connection controls operation.

5. Cleaning Mechanism: The filter cleaning mechanism shall consist of a spiral-moving suction scanner, constructed of a 316 stainless steel assembly. By opening a 1" flush valve, the scanner shall create high efficiency suction force on each of the 4 cleaning nozzles. During that time, the nylon brush nozzles shall clean the total area of the screen. The nozzle head shall contact the screen surface at a constant pressure in order to maximize cleaning efficiency. At 45 PSI, the flushing flow rate shall not exceed 90 gallons per minute.

6. Assuring a maximum flush flow rate of 110 gpm, regardless of pressure, shall be enabled by a flow control valve in the drain line. The cleaning cycle shall be completed in 32 seconds or less, consuming approximately 59 gallons. The minimum pressure required for flushing shall be 58 PSI during the flush cycle.

7. Driving Mechanism: The suction scanner shall be driven by a 0.5 hp (0.37 kW) electric motor that is connected to the suction scanner through a threaded shaft that travels inside a threaded bearing. The movement created by the electric motor shall cause the scanner to move in a spiral motion at a speed of 17 RPM (@208V AC 60 Hz). The control of the scanner by the electric motor shall be limited by two normally closed limit switches and monitored by the control panel.

8. Filtration Element: The filter element shall be of a construction of a combination of wedge and weave wire screens, consisting of four layers. The collective screen shall be made of 316L stainless steel. The screen's external support shall be constructed of wedge-wire. The fine weaved-wire screen shall be sandwiched (protected) between two 2000-micron weaved-wire additional layers. The total surface area of each screen shall be 5300 cm2 (822 sq in) and shall be able to withstand an internal to external pressure differential of 100 PSI without any damage.

9. Housing Construction (high pressure): The filter housing shall be of 316L stainless steel. The filter body shall have a maximum operating pressure of 360 PSI, and a maximum operating temperature of 120° F. The filter housing shall have the capability to accept filter elements with varying micron degrees, which are totally interchangeable in the same housing.

10. Control System: The filter control system shall consist of a NEMA4 PLC with HMI that controls all aspects of the filter's operation including: Monitoring the DPS and limit switches, and operating the flush valve, electric motor, flush line pump and by-pass valves. The control panel shall include a flush counter to monitor average flush intervals. Control features shall include dry contact outputs to remotely indicate flush in progress and fault situations, and inputs to remotely initiate a start or stop of the filtration system. The filter shall conform to international quality code ISO-14001.

11. Meets or exceeds all current US domestic quality requirements for filtration devices including, but not limited to, NSF Standard 61, ANSI, AWWA, ASE, and others.

12. Detention tank to receive backwash water: Capacity not less than 200 gallons. Filter discharge to tank connection via 2" flange to copper pipe into vented tank.

13. Construction: Filter components are integrated onto single skid that may be bolted to floor to resist filter movement during a seismic event.

14. Controls: Automatic for control of flush cycles and backwash; factory wired for single, external electrical connection.

15. Support: Skid mounting.

16. Capacity and Characteristics:

17. Filter Design: Continuous Flow: <135 gpm at up to 150 psi with pressure drop from 1 psi with clean screen up to 4.4 psi upon which backwash of screen is triggered. (See operations.)

B. Filter Operation Description

1. The filter is comprised of a housing with two separate chambers within. The first chamber, with the filtration screen, connects to the water inlet port; the second is the backwashing chamber.

2. Water circulates through the body of the filter from the inside out. The collected solids in suspension are retained within the filtering component (the screen). This chamber connects to the filtered water outlet to supply the intended operation: potable water, process water, cooling tower water, etc.

3. The outlet of the backwashing chamber is connected to the drainage valve that enables rinse water run off, once the self-cleaning process has been initiated. The backwashing chamber is otherwise sealed from the filtration chamber.

4. The suction scanner is located on the central axis of the filtration element, and is hydraulically connected to the backwashing chamber. The scanner's suction nozzles terminate in nylon bristles that extend to within a few microns of the screen mesh. Nozzle positioning is calibrated to effect contact with the entire inner surface of the mesh as a consequence of the motorized spiral motion of the scanner, combining longitudinal motion with rotation.

C. Operation Summary

1. The water enters the filtration chamber and passes through the fine screen to produce surface mechanical filtration at the filtration degree according to the selected screen rating, from 10 to 2000 microns.

2. As the collected particles accumulate on the inner surface of the fine mesh, their build-up causes a progressive loss of pressure between the filter inlet and outlet. When the differential pressure reaches about 4.4 psi, two analog transducers initiate the backwashing sequence. Other backwash methods are available, including time delay, combined pressure and time delay, or continuous backwashing.

3. When the differential pressure switch reaches 4.4 psi, the drainage valve is signaled to open. This generates a pressure differential between outside (atmospheric pressure) and inside the filter (working pressure), which induces a current of fast-flowing water that rushes through the mesh and out through the inner hole of the suction scanner nozzles. At this point a signal is sent to the motor to start operating.

4. The result of simultaneous spiral movement of the suction scanner inside the filter and the suction effect from the nozzles on the accumulated filter cake enables successful cleaning of the fine screen.

5. During the 32-second self-cleaning process, filtered water flows without interruption to the intended application.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of filters.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls and floors for suitable conditions where filters will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT MOUNTING

A. Equipment Mounting: Ancor filters on concrete bases.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of concrete base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.3 AUTOMATIC SCREEN FILTER INSTALLATION

A. Install filter tanks on concrete base.

1. Exception: Omit concrete bases if installation directly on floor is indicated.

B. Install seismic restraints for automatic screen filters tanks and accessories and anchor to building structure.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Make piping connections between water filtration equipment and dissimilar-metal water piping with dielectric fittings. Comply with requirements for dielectric fittings specified in Section 22 11 16 "Domestic Water Piping."

D. Install shutoff valves on feedwater-inlet and filtrate-outlet piping of each water filtration equipment filter and on inlet and outlet headers.

1. Comply with requirements for metal general-duty valves specified in Section 22 05 23 "Valves for Plumbing Piping."

2. Comply with requirements for plastic valves specified in Section 22 11 16 "Domestic Water Piping."

3. Exception: Water filtration equipment with factory-installed shutoff valves at locations indicated.

E. Install pressure gages on feedwater-inlet and filtrate-outlet piping of each water filtration equipment filter. Comply with requirements for pressure gages specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

1. Exception: Water filtration equipment with factory-installed pressure gages at locations indicated.

F. Install valved bypass water piping around each water filtration equipment filter.

1. Comply with requirements for metal general-duty valves specified in Section 22 05 23 "Valves for Plumbing Piping."

2. Comply with requirements for plastic valves specified in Section 22 11 16 "Domestic Water Piping."

3. Comply with requirements for water piping specified in Section 22 11 16 "Domestic Water Piping."

G. Install backward holding tanks as needed.

H. Install drains as indirect wastes to spill into open drains or over floor drains.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Domestic water filtration equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

B. Sample filter filtrate after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water filtration equipment.

END OF SECTION 22 32 00

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SECTION 22 33 00 - DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Commercial storage domestic-water heaters.

2. Instantaneous tankless domestic-water heaters.

3. Domestic water heater accessories.

B. Section does not include requirements for outdoor water storage tank heaters. See specification 221219 for information.

1.3 ACTION SUBMITTALS

A. Shop Drawings:

1. For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

2. Wiring Diagrams: For power, signal, and control wiring.

B. LEED Submittals:

1. Product Data for Prerequisite EA 2: Documentation indicating that units comply with applicable requirements in ASHRAE/IESNA 90.1, Section 7, "Service Water Heating."

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of domestic-water heater, from manufacturer.

B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

C. Source quality-control reports.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.7 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test domestic-water heat exchangers to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heat exchangers will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate heaters location with other equipment, ductwork, architectural and structural elements. Provide clearances required for heater maintenance and parts pull-out without relocating other equipment or building elements.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.

b. Faulty operation of controls.

c. Deterioration of metals, metal finishes, and other materials beyond normal use.

d. Insert.

B. Warranty Periods: From date of Substantial Completion.

1. Electric Heaters

a. Commercial, Domestic-Water Booster Heaters:

1) Controls and Other Components: Three years.

b. Commercial, Storage, Domestic-Water Heaters:

1) Storage Tank: Five years.

2) Controls and Other Components: Three years.

c. Commercial, Light-Duty, Storage, Domestic-Water Heaters:

1) Storage Tank: Three years.

2) Controls and Other Components: Two years.

d. Tankless, Domestic-Water Heaters: Two year(s).

e. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Electric, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

   a. American Water Heaters.

   b. Bradford White Corporation.

   c. Cemline Corporation.

   d. Electric Heater Company (The).

   e. GSW Water Heating.

   f. HESco Industries, Inc.

   g. Lochinvar Corporation.

   h. Precision Boilers, Inc.

   i. PVI Industries, LLC.

   j. RECO USA.

   k. Rheem Manufacturing Company.

   l. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.

3. Standard: UL 1453 – Larger than 120 gallon capacity and UL 174 120 gal. capacity and less

4. Storage-Tank Construction: ASME-code for 120 gallons and greater steel ferritic alloy vertical arrangement.

   a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.

      1) ASME B1.20.1 for threaded piping NPS 2-1/2 (DN 65) and smaller

      2) NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.

      3) NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges, and according to ASME B16.24 for copper and copper-alloy flanges.

   b. Pressure Rating: 150 psig (1035 kPa).

   c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

5. Factory-Installed Storage-Tank Appurtenances:

   a. Anode Rod: Replaceable magnesium.

   b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.

   c. Insulation: Comply with ASHRAE/IESNA 90.1. or ASHRAE 90.2

   d. Jacket: Steel with enameled finish.

   e. Heating Elements: Electric, screw-in or bolt-on immersion type.

   f. Temperature Control: Adjustable thermostat.

   g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.

   h. 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, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

6. Special Requirements: NSF 5 construction.

7. Features and Equipment for Heavy Duty Heaters Larger than 120 gal and 12 KW:

   a. Heating Elements

      Heavy-duty heating elements rated at 20 40 80 Watts per square inch heat density.

   b. Electrical Circuitry

      1) 120V control circuit (distributed from 208/240V supply, where required)

      2) Control circuit transformer (480V supply)

      3) Supply voltage 480V, 3Ø

      4) Fused magnetic contactors for each power circuit (50 amp maximum per circuit on 3Ø units)

      5) Control circuit switch, fuse, and pilot light

      6) Remote on-off terminals

   c. Operating And Safety Controls

      1) Upper and lower immersion operating thermostats (one on horizontal tanks of 250 gallons or less)

      2) Immersion temperature limiting device (high limit)

3) Electronic low water cutoff

d. Electronic Operating Control Options

1) Programmable electronic operating control with digital temperature readouts

2) Cable to connect the electronic operating control to a Building Automation System

3) Alarm, including local audible alarm

4) Local audible alarm for noisier environments, includes silencing switch

5) Protocol gateway: Coordinate with control contractor.

e. Optional Features and Equipment

1) Intra-tank circulator (INTRA)

a) < 1000 gallon tank: 1/25 hp, 115V, 3/4 amp, factory wired

b) ≥ 1000 gallon tank: 1/3 hp, 115V, 8 amp, separate supply required

2) Shunt trip circuit interrupter with on/off handle

3) Safety door interlock

4) Water pressure gauge on drain piping

5) Manual-reset immersion temperature limiting device

6) Dial temperature and pressure gauges – panel mounted

7) Tridicator on outlet piping

8) Audible alarm with silencing switch

9) Switched contacts for remote alarm notification

10) Digital seven-day time clock with battery backup

11) 120V control circuit transformer (208V and 240V)

2.2 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS

A. Flow-Control, Thermostat Control Electric, Tankless, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, are limited to, the following:

a. Bosch Water Heating.

b. Chronomite Laboratories, Inc.

c. Eemax, Inc.

d. E-Tankless Water Heaters Corp.

e. Keltech, Inc.

f. Niagara Industries, Inc.

g. Rheem.

2. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.

3. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.

a. Connections: ASME B1.20.1 pipe thread.

b. Pressure Rating: 150 psig (1035 kPa) .

c. Heating Element: Resistance heating system.

d. Temperature Control: Flow-control fitting.

e. Safety Control: High-temperature-limit cutoff device or system.

f. Jacket: Aluminum or Steel with enameled finish or Stainless Steel Housing.

g. Wiring: Hard wired.

4. Support: Bracket for wall mounting.

5. Additional Accessories

a. Digital microprocessor for temperature control.

b. Assembly kit for multiple heaters.

c. Integral in-line strainer upstream of the water heater.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. AMTROL Inc.

b. Flexcon Industries.

c. Honeywell International Inc.

d. Pentair Pump Group (The); Myers.

e. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.

f. State Industries.

g. Taco, Inc.

h. Wessels Co.

2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

3. Construction:

a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.

b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

c. Air-Charging Valve: Factory installed.

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water.

1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

2. Comply with requirements for balancing valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

F. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

2. Other, Domestic-Water Heaters: ASME rated and stamped.

G. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

2. Other, Domestic-Water Heaters: ASME rated and stamped.

H. Vacuum Relief Valves: ASME rated and stamped. ANSI Z21.22/CSA 4.4-M.

I. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches (457 mm) above the floor.

J. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base at least 4” (100 mm) high. Comply with requirements for concrete base specified in Section 03 30 00 "Cast-in-Place Concrete" and Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."

1. Exception: Omit concrete bases for domestic-water heaters if installation on stand, bracket, suspended platform is indicated.

2. Maintain manufacturer's recommended clearances, including space for pull-out heater parts without relocating other equipment.

3. Arrange units so controls and devices that require servicing are accessible.

4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.

5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

7. Install anchor bolts to elevations required for proper attachment to supported equipment.

8. Anchor domestic-water heaters to substrate.

B. Tankless, Domestic-Water Heater Mounting: Install tankless, domestic-water heaters at least 18 inches (457 mm) above floor on wall bracket .

1. Maintain manufacturer's recommended clearances.

2. Arrange units so controls and devices that require servicing are accessible.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

5. Anchor domestic-water heaters to substrate.

C. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

G. Install thermometer on inlet and outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

H. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

I. Install pressure-reducing valve with integral bypass relief valve in electric, domestic-water booster-heater inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of 25 psig (172 kPa) . Comply with requirements for pressure-reducing valves and water hammer arresters specified in Section 22 11 19 "Domestic Water Piping Specialties."

J. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

K. Fill domestic-water heaters with water.

L. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 22 11 16 "Domestic Water Piping."

B. Drawings indicate general arrangement of piping, fittings, and specialties.

C. Where installing piping adjacent to domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in

B. Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain installed domestic-water heaters. Provide start-up report to the ownership.

END OF SECTION 22 33 00

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SECTION 22 41 00 – FIXTURES AND APPLIANCES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following plumbing fixtures, appliances and related roughing:

1. Faucets for lavatories, and sinks.
2. Laminar-flow faucet-spout outlets.
3. Flushometers.
4. Toilet seats.
5. Protective shielding guards.
6. Fixture supports.
7. Interceptors for individual fixtures.
8. Disposers.
9. Drinking fountains.
10. Electric water coolers.
11. Water-station coolers.
12. Water closets.
13. Urinals.
14. Lavatories.
15. Commercial sinks.
16. Wash fountains.
17. Kitchen sinks.
18. Service sinks.
19. Mop receptors.
20. Laundry trays.

B. This section does not include:

1. Interceptors serving multiple fixtures and appliances.

2. Food service fixtures and appliances. Sanitary plumbing fixtures located within food service areas are included.

C. For the purpose of this specification, the term “plumbing fixture” also includes appliances that require plumbing connections. Requirements listed below for plumbing fixtures also apply to the appliances that require plumbing connections.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Division 02 Section "Water Distribution" for exterior plumbing fixtures and hydrants.

2. Division 10 Section "Toilet and Bath Accessories."

3. Division 22 Section 22 05 00 “Common Work Results for Plumbing”.

4. Division 22 Section 22 11 19 "Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.

5. Division 22 Section 22 32 00 "Water Filtration Equipment" for water filters.

6. This section is a part of each Division 22.

7. Division 26 “Electrical” for fixtures and appliances requiring power supply.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

E. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.

F. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

G. Fixture: drinking fountain or water cooler unless one is specifically indicated.

H. FRP: Fiberglass-reinforced plastic.

I. PMMA: Polymethyl methacrylate (acrylic) plastic.

J. PVC: Polyvinyl chloride plastic.

K. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.

L. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

M. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.4 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act" and local code; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers: for style classifications.

H. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

I. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers.

J. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.

2. Plastic Lavatories: ANSI Z124.3.

3. Plastic Laundry Trays: ANSI Z124.6.

4. Plastic Mop-Service Basins: ANSI Z124.6.

5. Plastic Sinks: ANSI Z124.6.

6. Plastic Urinal Fixtures: ANSI Z124.9.

7. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.

8. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.

9. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.

10. Vitreous-China Fixtures: ASME A112.19.2M.

11. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.

12. Water-Closet, Flushometer Tank Trim: ASSE 1037.

K. Comply with the following applicable standards and other requirements specified for lavatory and/or sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.

2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.

3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.

4. Faucets: ASME A112.18.1.

5. Hose-Connection Vacuum Breakers: ASSE 1011.

6. Hose-Coupling Threads: ASME B1.20.7.

7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.

8. NSF Potable-Water Materials: NSF 61.

9. Pipe Threads: ASME B1.20.1.

10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.

11. Supply Fittings: ASME A112.18.1.

12. Brass Waste Fittings: ASME A112.18.2.

L. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.

2. Brass and Copper Supplies: ASME A112.18.1.

3. Dishwasher Air-Gap Fittings: ASSE 1021.

4. Manual-Operation Flushometers: ASSE 1037.

5. Plastic Tubular Fittings: ASTM F 409.

6. Brass Waste Fittings: ASME A112.18.2.

7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

M. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
2. Dishwasher Air-Gap Fittings: ASSE 1021.
3. Flexible Water Connectors: ASME A112.18.6.
4. Floor Drains: ASME A112.6.3.
5. Grab Bars: ASTM F 446.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Off-Floor Fixture Supports: ASME A112.6.1M.
8. Pipe Threads: ASME B1.20.1.
9. Plastic Toilet Seats: ANSI Z124.5.
10. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of plumbing fixtures that fail in materials or workmanship within specified warranty period.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 12 of each type.
4. Provide hinged-top wood or metal box, or individual metal boxes, with separate compartments for each type and size of extra materials listed above.
5. Flushometer Tank, Repair Kits: Equal to 5 percent of amount of each type installed, but no fewer than 2 of each type.
6. Water-Closet Tank, Repair Kits: Equal to 5 percent of amount of each type installed.

7. Toilet Seats: Equal to 5 percent of amount of each type installed.

8. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

    a. Filter Cartridges: Equal to 20 percent of amount installed for each type and size indicated, but no fewer than 5 of each.

PART 2 - PRODUCTS

2.1 FAUCETS

A. Manufacturers:

1. Subject to compliance with requirements, provide products specified by the Architect.

2. If no product specified by the Architect: Subject to compliance with requirements, provide a comparable product by one of the following:

    a. American Standard Companies, Inc.

    b. Central Brass Manufacturing Company.

    c. Delta Faucet Company.

    d. Eljer.

    e. Gerber Plumbing Fixtures LLC.

    f. Grohe America, Inc.

    g. Hansgrohe Inc.

    h. Kohler Co.

    i. Moen, Inc.

    j. Speakman Company.

    k. Symmons Industries, Inc.

    l. T & S Brass and Bronze Works, Inc.

    m. Wolverine Brass, Inc.

B. Descriptions:

1. Lavatory Faucets: Single-control mixing or Single-control non-mixing or Two-handle mixing valve. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

2. Bathtub Faucets: Single-control mixing or Two-handle mixing or Three-handle mixing or Push-button, metering, non-mixing valve. Include hot- and cold-water indicators and tub spout. Coordinate faucet inlets with supplies.

3. Combination Bathtub/Shower Faucets: Single-handle pressure-balance or thermostatic or thermostatic/pressure-balance valve for bathtub and for shower. Include hot- and cold-water indicators; check stops; tub spout; and shower head, arm, and flange. Coordinate faucet inlets with supplies; coordinate outlet with diverter valve.

4. Shower Faucets: Single-handle pressure-balance or thermostatic or thermostatic and pressure-balance valve. Include hot- and cold-water indicators; check stops; and shower head, arm, and flange. Coordinate faucet inlets with supplies and outlet with diverter valve.

5. Sink Faucets: Kitchen faucet with spray, three-hole fixture or Kitchen faucet with spray, four-hole fixture or Kitchen faucet without spray or Laundry tray faucet or Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook or Bar sink faucet. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

2.2 FLUSHOMETERS

A. Manufacturers:

1. Subject to compliance with requirements, provide products specified by the Architect.

2. If no product specified by the Architect: Subject to compliance with requirements, provide a comparable product by one of the following:

a. Delany Co.

b. Delta Faucet Company.

c. Sloan Valve Company.

d. Zurn Plumbing Products Group.

e. TOTO USA, Inc.

3. Description: Flushometer for urinal and water-closet-type fixture. Include brass body with corrosion-resistant internal components, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

2.3 TOILET SEATS

A. Manufacturers:

1. Subject to compliance with requirements, provide products specified by the Architect.

2. If no product specified by the Architect: Subject to compliance with requirements, provide a product comparable with specified water closet, manufacturer's standard.

B. Seats for public toilets shall be open-front, no cover.

2.4 PROTECTIVE SHIELDING GUARDS

A. Manufacturers:

1. Subject to compliance with requirements, provide products by one of the following:

a. Engineered Brass Co.

b. McGuire Manufacturing Co., Inc.

c. TRUEBRO, Inc.

d. Zurn Plumbing Products Group.

B. Description:

1. Manufactured wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.5 FIXTURE SUPPORTS

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

1. Josam Company.

2. MIFAB Manufacturing Inc.

3. Tyler Pipe; Wade Div.

4. Watts Drainage Products Inc.

5. Zurn Plumbing Products Group.

B. Descriptions:

1. Water Closets: Combination carrier designed for accessible or standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space. Provide compact non-adjustable supports for individual toilets. Provide adjustable supports for two and more toilets in a row, unless noted otherwise on the drawings.

2. Urinals: Urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.

3. Lavatories: Lavatory carrier with exposed arms and tie rods, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.

   a. Accessible-Fixture Support: Include rectangular steel uprights.

4. Sinks: Sink carrier with exposed arms and tie rods for sink-type fixture. Include steel uprights with feet.

2.6 INTERCEPTORS FOR INDIVIDUAL FIXTURES

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Josam Company.

2. MIFAB Manufacturing Inc.

3. Tyler Pipe; Wade Div.

4. Watts Drainage Products Inc.

5. Zurn Plumbing Products Group.

2.7 DISPOSERS

A. Manufacturer:

1. Subject to compliance with requirements, provide products specified by the Architect.

2. If no product specified by the Architect: Subject to compliance with requirements, provide a comparable product by one of the following:

   a. American Standard Companies, Inc.

b. General Electric.

c. In-Sink-Erator; a div. of Emerson Electric Co.

d. KitchenAid.

e. Maytag Co.

f. WhiteRock Corp.

B. Description: Batch or Continuous-feed household, food-waste disposer. Include reset button; wall switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; NPS 1-½ (DN 40) outlet; dishwasher drain connector, quick-mounting, stainless-steel sink flange; antisplash guard; and combination cover/stopper.

1. Type: Batch or Continuous-feed household.

2. Model: Sound-insulated chamber and stainless-steel outer shell.

3. Motor: with overload protection.

2.8 DRINKING FOUNTAINS

A. Exterior Drinking Fountains:

1. Manufacturers: Subject to compliance with requirements, provide products specified by the Architect or Landscape Designer.

2. If no product specified by the Architect or Landscape Designer: Subject to compliance with requirements, provide a comparable product by one of the following:

a. Filtrine Manufacturing Company.

b. Halsey Taylor.

c. Haws Corporation.

d. Most Dependable Fountains, Inc.

e. Murdock, Inc.

f. Oasis Corporation.

3. Description: Free standing exterior drinking fountain with weather proof finish. Bi-level, where specified.

B. Interior Drinking Fountains:

1. Manufacturers: Subject to compliance with requirements, provide products specified by the Architect.

2. If no product specified by the Architect: Subject to compliance with requirements, provide a comparable product by one of the following:

a. Elkay Manufacturing Co.

b. Filtrine Manufacturing Company.

c. Halsey Taylor.

d. Haws Corporation.

e. Murdock, Inc.

f. Oasis Corporation.

3. Description: Wall mounted, recessed or semi-recessed type; bi-level where specified.

2.9 ELECTRIC WATER COOLERS

A. Manufacturers:

1. Subject to compliance with requirements, provide products specified by the Architect.

2. If no product specified by the Architect: Subject to compliance with requirements, provide a comparable product by one of the following:

a. Elkay Manufacturing Co.

b. Halsey Taylor.

c. Haws Corporation.

d. Larco, Inc.

e. Oasis Corporation.

f. Sunroc Corp.

B. Description:

1. Wall mounted, recessed or semi-recessed as specified.

2. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.

3. Drain(s): Grid with NPS 1-¼ (DN 32) minimum horizontal waste and trap complying with ASME A112.18.1.

4. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

   a. Capacity: As specified.

   b. Electrical Characteristics: 120-V ac; single phase; 60 Hz.

5. Provide remote water cooler where specified.

2.10 WATER CLOSETS AND URINALS

A. Manufacturers:

1. Subject to compliance with requirements, provide products specified by the Architect.

2. If no product specified by the Architect: Subject to compliance with requirements, provide a comparable product by one of the following:

   a. Crane.

   b. American Standard Companies, Inc.

   c. Zurn

   d. Gerber.

   e. Eljer.

   f. Kohler Co.

   g. TOTO USA, Inc.

2.11 LAVATORIES

A. Manufacturers:

1. Subject to compliance with requirements, provide products specified by the Architect.

2. If no product specified by the Architect: Subject to compliance with requirements, provide a comparable product by one of the following:

a. American Standard Companies, Inc.

b. Eljer.

c. Kohler Co.

d. Crane Plumbing, L.L.C./Fiat Products.

e. Gerber Plumbing Fixtures LLC.

f. Sterling Plumbing Group, Inc.

g. TOTO USA, Inc.

2.12 SINKS - STAINLESS STEEL

A. Manufacturers:

1. Subject to compliance with requirements, provide products specified by the Architect.

2. If no product specified by the Architect: Subject to compliance with requirements, provide a comparable product by one of the following:

a. Advance Tabco.

b. Elkay Manufacturing Co.

c. Just Manufacturing Company.

d. Zurn.

2.13 KITCHEN AND BAR SINKS

A. Manufacturers:

1. Subject to compliance with requirements, provide products specified by the Architect.

2. If no product specified by the Architect: Subject to compliance with requirements, provide a comparable product by one of the following:

a. Elkay Manufacturing Co.

b. Eljer.

c. Kohler Co.

d. Gerber Plumbing Fixtures LLC.

e. American Standard Companies, Inc.

f. Just Manufacturing Company.

g. Moen, Inc.

h. Sterling Plumbing Group, Inc.

2.14 SERVICE SINKS

A. Manufacturers:

1. Subject to compliance with requirements, provide products specified by the Architect.

2. If no product specified by the Architect: Subject to compliance with requirements, provide a comparable product by one of the following:

a. American Standard Companies, Inc.

b. Crane Plumbing, L.L.C./Fiat Products.

c. Eljer.

d. Kohler Co.

2.15 MOP RECEPTOR

A. Manufacturers:

1. Subject to compliance with requirements, provide products specified by the Architect.

2. If no product specified by the Architect: Subject to compliance with requirements, provide a comparable product by one of the following:

a. Acorn Engineering Company.

b. Crane Plumbing, L.L.C./Fiat Products.

c. Florestone Products Co., Inc.

d. Precast Terrazzo Enterprises, Inc.

e. Zurn Plumbing Products Group.

2.16 LAUNDRY TRAYS

A. Manufacturers:

1. Subject to compliance with requirements, provide products specified by the Architect.

2. If no product specified by the Architect: Subject to compliance with requirements, provide a comparable product by one of the following:

a. Commercial Enameling Company.

b. Eljer.

c. Crane Plumbing, L.L.C./Fiat Products.

d. Florestone Products Co., Inc.

e. Gerber Plumbing Fixtures LLC.

f. Zurn Plumbing Products Group.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.

2. Use carrier supports without waste fitting for fixtures with tubular waste piping.

3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

4. Use mounting frames for recessed water coolers, unless otherwise indicated.

5. Set remote water coolers on floor, unless otherwise indicated.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Provide ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Section 22 05 23 "Valves for Plumbing Piping" of this Division.

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

N. Install toilet seats on water closets.

O. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

P. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

Q. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.

2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

R. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

S. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Section 22 05 00 “Common Work Results for Plumbing” of this Division.

T. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

U. Coordinate with electrical contractor power supply required for hard-wired fixtures and appliances and locations of receptacles required for plug-in appliances.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections of this Division. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Electrical Contractor to connect wiring according to Division 26 Section "Conductors and Cables." This contractor shall provide and coordinate required connection points and receptacles.

3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

F. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.

1. Remove and replace malfunctioning units and retest as specified above.

2. Report test results in writing.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers, hot-water dispensers and controls. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

E. Install fresh batteries in sensor-operated mechanisms.

F. Adjust drinking fountain/water cooler fixture flow regulators for proper flow and stream height.

G. Adjust water coolers and hot water disposers temperature settings.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.

2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

C. Clean fixtures, on completion of installation, according to manufacturer’s written instructions.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of permanent plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 41 00

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DIVISION 23 – HVAC INDEX

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SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This Section includes general administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and the other sections of Division 23.

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

1. Sustainable Design Requirements – Division 01.
2. Cast-In place concrete – Division 03- Concrete
3. Steel Roof Decking - Division 05- Metals
4. Metal Fabrications - Division 05- Metals
5. Flashing Wall and Roof Penetrations - Division 07- Thermal and Moisture Protection
6. Sealants and Caulking - Division 07- Thermal and Moisture Protection
7. Painting - Division 09 - Finishes
8. Division 21 – Fire Protection
9. Division 22 – Plumbing
10. Division 23 – Heating, Ventilating and Air Conditioning – All Sections
11. Division 26 – Electrical
12. Other Divisions of this Specification where applicable

1.3 REFERENCE STANDARDS

A. The reference standards listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. Air-Conditioning, Heating and Refrigeration Institute (AHRI).

C. American National Standard Institute (ANSI):

D. Air Moving and Conditioning Association (AMCA):

E. American Society of Mechanical Engineers (ASME):

F. American Society for Testing and Materials (ASTM):

G. National Fire Protection Association (NFPA):

H. American Association of Balancing Contractors (AABC).

I. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

J. American Welding Society (AWS)

K. Environmental Protection Agency (EPA).

L. National Environmental Balancing Bureau (NEBB).

M. National Electrical Code (NEC)

N. Occupational Safety and Health Administration (OSHA).

O. Underwriters Laboratories (UL).

P. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and as specified in Division 01 Section titled "SUBMITTAL PROCEDURES."

B. Prior to purchasing any equipment or materials, a list of their manufacturers shall be submitted for review.

C. Prior to assembling or installing the work, the following shall be submitted for review:

1. Scale drawings indicating insert and sleeve locations.

2. Scale drawings showing all piping and duct runs with sizes, elevations, equipment service clearance and appropriate indication of coordination with other trades. This submission to us shall consist of an electronic file submittal and 2 paper prints.

3. Catalog information, factory assembly drawings and field installation drawings as required for a complete explanation and description of all items of equipment.

4. Coordination drawings for access panel and door locations.

5. Shop drawings detailing fabrication and installation for supports for mechanical materials and equipment.

6. Mechanical Contractor shall submit complete air handling/air conditioning unit sheet metal and piping shop drawings to the unit manufacturer prior to submission to the Engineer. The unit manufacturer shall approve the air performance and acoustical performance of the units in the location and with the ductwork and piping configuration and construction as indicated on the shop drawing. Air handling/air conditioning unit manufacturer shall indicate approval directly on the shop drawing.

7. Welder Certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" in this section.

D. Documents will not be accepted for review unless:

1. They include complete information pertaining to appurtenances and accessories.

2. They are submitted as a package where they pertain to related items.

3. They are properly marked with service or function, project name, where they consist of catalog sheets displaying other items which are not applicable.

4. List of all deviations and exceptions from the specified requirements for the product is provided on the first sheet of the submittal.

5. They indicate the project name and address along with the Contractor's name, address and phone number.

6. They are properly marked with external connection identification as related to the project where they consist of standard factory assembly or field installation drawings.

E. Shop Drawing Review

1. The purpose of the review of shop drawings is to maintain integrity of the design. Unless the contractor clearly points out changes, substitutions, deletions or any other differences between the submission and the Contract Documents in writing on the Contractor's letterhead, review by the Engineer or Architect does not constitute acceptance. It is not to be assumed that the engineer has read the text nor reviewed the technical data of a manufactured item and its components including where the Vendor has pointed out differences between his product and the specified model.

2. Upon receipt of the approved manufacturers and material suppliers list, the Contractor shall immediately obtain complete Shop Drawings, Product Data and Samples and equipment and material Specification Compliance Review documents from the manufacturers, suppliers, vendors and all Division 23 Contractors, for all materials and equipment as specified herein in various sections of the specifications and shall submit data and details of such materials and equipment for review by the Architect and Engineer. Prior to submission of the Shop Drawings, Product Data and Samples to the Architect and Engineer, the Contractor shall thoroughly review the Shop Drawings, Product Data and Samples and certify they are in compliance with the Contract Documents. The Contractor shall provide a compliance review ("Compliance Review") of the applicable Drawings, Specifications and Addenda for all equipment and materials. The Compliance Review will be a paragraph by paragraph review of the Specifications with the following information marked for each Specification section paragraph or in the margin of the original Specification and any subsequent Addenda.

    a. "C": Comply with no exceptions.

    b. "D": Comply with minor deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.

    c. "E": Exception. Equipment, product or material does not comply. For each and every exception, provide a numbered footnote with reasons for each exception and suggest possible alternatives for the owner's consideration.

    d. "N/A": The specification paragraph does not apply to the proposed equipment, material or product.

    e. Unless a deviation or exception is specifically noted in the Compliance Review, it is assumed that the Contractor is in complete compliance with the Contract Documents. Deviations or exceptions taken in cover letters, subsidiary documents, by omission or by contradiction does not relieve the Contractor from being in complete compliance unless the exception or deviation has been specifically noted (explicitly, not by implication) in the Compliance Review.

3. It is the responsibility of the contractor to confirm all dimensions, quantities, and the coordination of materials and products supplied by him with other trades. Review of shop drawings containing errors does not relieve the contractor from making corrections at his expense.

4. Substitutions of equipment, systems, materials, temperature controls must be coordinated by the Contractor with his own or other trades which may be involved with the item, such as, but not limited to, equipment substitutions which change electrical requirements, or hanging or support weights or dimensions.

5. Any extra changes or credits which may be generated by other trades due to substitutions will not be accepted unless the Contractor has an agreement in writing with the Owner.

6. Proposed substitutions shall be in accordance with the requirements of the section governing substitutions. Substitutions of equipment, systems, etc. requiring approval of local authorities must comply with such regulations and be filed at the expense of the Contractor (should filing be necessary). Substitutions are subject to approval or disapproval by the Engineer. The contractor in offering substitutions shall hold the Owner and Engineer harmless if the substituted item is an infringement of patent held by the specified item.

F. Explanation of Shop Drawing Stamp

1. Reviewed - No Exception Taken: indicates that we have not found any reason why this item should not be acceptable within the intent of the contract documents.

2. Exception Taken As Noted: indicates that we have found questionable components which if corrected or otherwise explained make the product acceptable.

3. Revised and Resubmit: indicates that this item should be resubmitted for review before further processing.

4. Resubmit Specified Item: indicates that the item will not meet the intent of the Contract.

5. Incomplete - Resubmit: Indicates that the submission is not complete and ready for review by the Architect or Engineer.

6. Verified for Electrical Services: Indicates that the electrical requirements has been confirmed with the electrical contract documents.

7. Architects Review Required: Indicates that the submission will required the Architects review.

8. Structural Review Required: Indicates that the submission will require the Structural Engineer’s review.

9. Acoustical Consultant Review Required: Indicates that the submission will require the acoustical consultant’s review.

10. No shop drawing stamp or note shall constitute an order to fabricate or ship. Such notification can only be performed by the Project Manager for Construction, the Contractor scheduling his own work, or the Owner.

11. The Contractor is responsible for having "Reviewed" copies of shop drawings bearing the “Reviewed - No Exception Taken” stamp of the Architect/Engineer or Owner's Consultant are kept on the job site and work is implemented in the field in accordance with these documents.

12. Where information from one Contractor is required by another contractor, it is the responsibility of the contractors to exchange information and coordinate their work.

1.5 QUALITY ASSURANCE

A. Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code Steel."

B. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions of ASME B31 Series "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

C. Products Criteria:

1. All equipment furnished as part of the work shall comply with the latest editions of all applicable state and municipal "energy codes." Provide certification from the equipment suppliers for all energy-consuming equipment that the equipment fully complies with these codes. Equipment submissions will not be accepted for review unless accompanied by such certification in writing.

2. All equipment and materials shall be new and without blemish or defect.

3. All products and equipment shall be tested and/or listed and labeled by approved agency, such as Underwriters Laboratories (UL), according to prescribed standard or by approved agency according to New York City Office of Technical Certification and Research (OTCR) approved criteria. It is the responsibility of this trade to demonstrate or obtain and pay for all costs and fees of such approval and, when applicable, to prepare and submit an alternative product application to OTCR for review and approval.

4. All equipment and materials shall be free of asbestos.

5. Electrical equipment and materials shall be products which will meet with the acceptance of the agency inspecting the electrical work. Where such acceptance is contingent upon having the products examined, tested and certified by Underwriters or other recognized testing laboratory, the product shall be examined, tested and certified. Where no specific indication as to the type or quality of materials or equipment is indicated, a first class standard article shall be furnished.

6. It is the intent of these specifications that wherever a specific manufacturer of a product is specified or scheduled, and the specifications include other approved manufacturers or the terms "other approved" or "or approved equal" or "equal" are used, the submitted item must conform in all respects to the specified item. Consideration will not be given to claims that the submitted item meets the performance requirements with lesser construction (such as lesser heat exchange surface, smaller motor HP, etc.). Performance as delineated in schedules and in the specifications shall be interpreted as minimum performance. In many cases equipment is oversized to allow for pick-up loads which cannot be delineated under the minimum performance.

7. All equipment of one type (such as fans, pumps, coils, etc.), shall be the products of one Manufacturer.

8. Substituted equipment or optional equipment where permitted and approved, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether approved or not, shall be replaced at the Contractor's expense. Any modifications of related systems as a result of substitutions shall be made at the Contractor's expense.

9. Note that the approval of shop drawings, or other information submitted in accordance with the requirements hereinbefore specified, does not assure that the Engineer, Architect, or any other Owner's Representative, attests to the dimensional accuracy or dimensional suitability of the material or equipment involved or the ability of the material or equipment involved or the mechanical performance of equipment. Approval of Shop Drawings does not invalidate the plans and specifications if in conflict, unless a letter requesting such change is submitted and approved on the Engineer's letterhead.

10. Substitutions of Mechanical Equipment for that shown on the schedules or designated by model number in the specifications will not be considered if the item is not a regular cataloged item shown in the current catalog of the manufacturer.

D. Manufacturer's Recommendations: Where installation procedures of any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Unit shall be stored and handled in accordance with manufacturer's instructions.

C. Unit shall be shipped with all listed items and control wiring factory installed unless noted on the submittals and approved prior to shipment.

D. Unit shall be shipped complete as specified. Parts for field installation shall not be shipped and stored on site without prior approval.

E. Rigging: Units shall be fully assembled. Units requiring disassembly for rigging shall be factory assembled and tested. Disassembly, reassembly and testing shall be supervised by the manufacturer's representative.

F. Unit shall be shipped with firmly attached labels that indicate name of manufacturer, model number, serial number, and plan tagging.

G. The Vendor shall shrink wrap all electronic equipment and spare parts prior to shipping. Spare parts are to be delivered at time of owner acceptance.

H. Deliver, store and handle all materials to keep clean and protected from damage.

I. Store products in shipping containers and maintain in place until installation.

J. Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

K. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.

L. Protect flanges, fittings, and piping specialties from moisture and dirt.

M. Protect equipment and other materials from damage after installed from construction debris and other damage.

1.7 PRECONSTRUCTION CONFERENCE PRIOR TO START OF WORK

A. Prior to commencing any Work, the CM, together with designated major Contractors, shall confer with the Architect and Engineer concerning the Work under the Construction Contract.

B. The pre construction conference will be conducted under the leadership of the CM and will occur soon after the CM notifies the Subcontractors of contract award. The pre construction conference will focus on items such as the expedited submittal review procedure, interface and coordination between Contractor work scope, the CM's project site rules and requirements, temporary utility requirements, CM's construction schedule, etc.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

C. Coordinate the installation of required supporting devices and set sleeves in poured in place concrete and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

E. Coordinate connection of electrical services.

F. Coordinate connection of mechanical systems with overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

G. Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces. See paragraph titled “Separation of Work Between Trades” to determine whether access panels and doors the responsibility of the Contractor for Division 08 or the Contractor responsible for Division 23.

H. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

1.9 SUSTAINABLE DESIGN REQUIREMENTS

A. Implement practices and procedures to meet the project’s environment goals which include achieving LEED (Leadership in Energy and Environmental Design) green building certification. Ensure that the requirements related to these goals, as defined in Division 01 and this section are implemented to the fullest extent. It is the Contractor’s responsibility to refer to the applicable LEED version being followed for this project and comply with the specific requirements. The Contractor shall inform the Architect and LEED Consultant should proposed substitutions or changes affect the stated LEED requirements. Substitutions, or other changes to the work proposed by the contractor or their Subcontractors, shall not be allowed without express written consent of the Architect and LEED Consultant.

1.10 COORDINATION

A. Arrange for duct spaces, pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

D. Provide all designating signs for shutoff valves, control valves, alarms, and the like, as required by the agencies having jurisdiction.

1.11 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 01 Section titled "PROJECT COORDINATION," and in accordance with Section HVAC trade coordination drawings to a scale of 3/8"=1'-0" or larger; detailing major elements, equipment components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. The coordination drawings shall be produced using AutoCad 2011 or later software. The design drawings will be made available on disks in AutoCad format for use as a basis for the "Coordination" drawings. These documents remain the property of Cosentini Associates and shall be used for no other purpose without expressed, written consent. The contractor shall assume all liabilities resulting from unauthorized use or modifications to the drawings.

2. Indicate the proposed locations of piping, ductwork, equipment, and materials. Include the following:

   a. Planned piping layout, including valve and specialty locations and valve stem movement.
   b. Planned duct system layout, including elbow radii and duct accessories.
   c. Clearances for supports.
   d. Clearances for installing and maintaining insulation.
   e. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
   f. Equipment connections and support details.
   g.
   h. Sizes and location of required concrete pads and bases.
   i. Clearances as required by Electric Code.

3. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

4. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

5. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, access doors and other ceiling-mounted items.

B. HVAC COORDINATION DRAWINGS

1. This Contractor shall prepare a complete set of construction Coordination Drawings showing all of the HVAC work (equipment, piping, ductwork, conduit, etc.) to be installed as part of the work of this section of the specifications.

2. The Coordination Drawings shall be prepared on electronic media (CADD) at not less than 3/8": 1'-0" scale.

3. Requirements for vibration isolation shall be shown on the coordination drawings by each trade.

4. The HVAC coordination drawings, shall serve as the base drawing to which all other contractors will overlay and add their work.

5. This Trade after showing all of the HVAC work shall forward the reproducible Coordination Drawings to the Plumbing Contractor.

6. The sequence of coordination drawings shall be HVAC-PLBG-FP-ELEC-CM/GC.

7. The HVAC Contractor shall be designated as the lead contractor in the development of the composite layering process and shall be responsible for electronically restacking the various trade layers into the final composite (CADD) Drawings. Each trade shall draw their Work on separate layers represented by individual colors.

8. The HVAC Contractor shall attend a series of meetings arranged by the General Contractor to resolve any real or apparent interferences or conflicts with the work of the other Contractors or with ceiling heights shown on the architectural drawings.

9. The HVAC Contractor shall then make adjustments to his work on the Coordination Drawings to resolve any real or apparent interferences or conflicts.

10. After any real or apparent interferences and conflicts have been incorporated into the Coordination Drawings, the HVAC Contractor shall “sign-off” the final Coordination Drawings.

11. The HVAC Subcontractor shall not install any of his work prior to sign-off of final Coordination Drawings. If HVAC work proceeds prior to sign-off of Coordination Drawings, any change to the HVAC work to correct the interferences and conflicts which result will be made by the HVAC Contractor at no additional cost to the project.

12. Coordination Drawings are for the HVAC Contractor’s and Owner’s use during construction and shall not be construed as replacing any shop, as-built, or Record Drawings required elsewhere in these Contract Documents.

13. Review of Coordination Drawings shall not relieve the HVAC Contractor from his overall responsibility for coordination of all work performed pursuant to the Contract or from any other requirements of the Contract.

1.12 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1. In addition to the requirements specified in Division 1, comply with the following.

1. A complete set of "as-built" or record drawings shall be made up and delivered to the Architect.

2. The drawings shall show:-

a. Ductwork mains and branches, size and location, for both exterior and interior; locations of all dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair.

b. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 23; Section titled “Identification for HVAC Piping, Ductwork and Equipment”. Indicate horizontal locations of underground piping.
c. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
d. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
e. Updating of all equipment schedule sheets.

B. This trade shall submit the "as-built" set for approval by the building department, when required by the jurisdiction.

C. Prior to developing any “as-built” drawings, the Contractor shall coordinate with the Owner, Architect, Engineer and other Contractors the drawing layers, colors, etc. of the CAD drawings.

D. The drawings shall be produced using AutoCAD software. The design drawing files will be made available should it be determined that such files would serve as suitable backgrounds for the "as-built" drawings. These documents remain the property of Cosentini Associates and shall be used for no other purpose without expressed, written consent. The contractor shall assume all liabilities resulting from unauthorized use or modifications to the drawings.

E. CAD files shall each correspond to a single drawing sheet and have all of the x-refs bound to the file. CAD fonts that are not in the standard AutoCAD group shall be embedded into the DWG file.

F. "As-built" information shall be submitted as follows:

1. BIM or CADD electronic drawing files on CD-R or DVD-R in proper format.

2. One (1) set of reproducible drawings.

3. Two (2) sets of blueprints.

G. The quantity of design drawings which are made available shall in no way be interpreted as setting a limit to the number of drawings necessary to show the required "as-built" information.

H. Progress prints of record drawings shall be submitted monthly during the construction period for Architect's review.

I. As-built drawings for filing with the Building Department (where required) shall be prepared at the same scale, in the same plan format and use the same symbols and nomenclature as the plans filed by Engineer of Record with the Building Department for “Building Permit.”

1.13 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 01. In addition to the requirements specified in Division 01, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions and lubrication charts and schedules.

5. List of spares: recommended for normal service requirements.

6. Parts list: identifying the various parts of the equipment for repair and replacement purposes.

7. Instruction books may be standard booklets but shall be clearly marked to indicate applicable equipment.

8. Wiring diagrams: generalized diagrams are not acceptable, submittal shall be specifically prepared for this project.

9. Automatic controls: diagrams and functional descriptions. (See control specification for additional requirements).

1.14 CODES, PERMITS AND INSPECTIONS

A. All work shall meet or exceed the latest requirements of all national, state, county, municipal and other authorities exercising jurisdiction over construction work at the project. These include, but are not limited to the following:

1. NFPA National Fire Codes

2. New York State Department of Health

3. New York State Building Code

4. All work shall meet or exceed USGBC LEED requirements when applicable.

B. All required permits and inspection certificates shall be obtained, paid for, and made available at the completion of the work.

C. Any portion of the work which is not subject to the approval of an authority having jurisdiction, shall be governed by the applicable sections of the overall National Fire Code, as published by the National Fire Protection Association.

D. Installation procedures, methods, and conditions shall comply with the latest requirements of The Federal Occupational Safety and Health Act (OSHA).

E. Prepare and submit to the building department a set of "as-built" record drawings for approval, in a form acceptable to the building department.

F. This contractor shall prepare all plans, amendments and pay all filing fees that will be required for the emergency or standby or an optional generator installation, including oil piping, engine exhaust, fuel tanks, and any or all parts of the system under the jurisdiction of the controlling agencies. Register the generator with the local agencies.

G. This Contractor shall be responsible for the installation and filing until the installation has been approved by the authorities having such jurisdiction.

1.15 SEPARATION OF WORK BETWEEN TRADES

A. The specifications for the overall construction delineate various items of work under separate trade headings. The list below sets forth this delineation to the extent that it affects the HVAC work.

B. In the absence of more detailed information, this list shall be taken as a specific instruction to the heating, ventilating and air conditioning trade to include the work assigned to it.

C. Indications that the heating, ventilating and air conditioning trade is to perform an item of work mean that it is to perform the work for its own accommodation only, except as specifically noted otherwise.

Oth = Divisions other than Electrical (Division 26) or Mechanical (Divisions 21, 22 & 23)

Plb = Plumbing

Htg = Heating, Ventilating & Air Conditioning

Elec = Electrical

F = Furnished

I = Installed

P = Provided (furnished and installed)

Item	Oth	Plb	Htg	Elec	Notes
Motors for mechanical equipment.			P		
Motor Starters for Mechanical Equipment			F	I	Specifications and Drawings delineate exception
Controls Device for Mechanical Equipment			P		

Item	Oth	Plb	Htg	Elec	Notes
Power wiring for mechanical equipment motors.				P	Specifications and drawings delineate exceptions.
Control wiring for motors.			P		Specifications and drawings delineate exceptions.
Wiring for automatic dampers.			P		Specifications and drawings delineate exceptions.
Temporary heat.	P				
Temporary water.	P				
Sealing of pressurized stairway, shafts and doors.	P				
Undercutting of doors and door louvers.	P				Supplying location where required included in HVAC.
Temporary light & power.	P				
Hoisting			P		
Rigging			P		
Cutting, chasing & patching	P				Cost where due to late installation or improper coordination of work is the responsibility of the delinquent trade.
Framed slots and openings in walls decks and slabs.	P				Coordination drawings are required from HVAC trade.
Sleeves through non-membraned slabs, decks and walls.			P		
Drilling & cutting of all holes in steel decks and precast slabs required for sleeves & supports.			P		
Sleeves through membraned slabs, decks and walls.			P		
Waterproof sealing of sleeves through membraned slabs, decks and walls.			P		
Fastenings			P		
Supports			P		
Base flashing to all roof penetrations	P				
Roof curb cap flashing.			P		
Roof curb base flashing	P				

Item	Oth	Plb	Htg	Elec	Notes
Concrete foundations, pads & bases inside buildings.	P				Furnishing of anchors, vibration mounts and seismic restraints included in the HVAC trade.
Concrete foundations, pads & bases outside buildings.	P				Furnishing of anchors, vibration mounts and seismic restraints included in the HVAC trade providing the associated equipment.
Field touch-up painting of damaged shop coats.			P		
Rustproofing field cut and assembled iron supporting frames and racks.			P		
Finish painting of exposed work.	P				Insulation coatings are by HVAC trade.
Ornamental grills.	P				Duct connections included in HVAC trade.
Exterior wall louvers.	P				Duct connections & safing of all unused portions of louvers (2" thick insulated panel) is by HVAC Trade.
Finished Wall and Ceiling Access Doors and Supporting Frames	I	F			HVAC Contractor shall locate the doors on approved shop drawings and shall be held responsible for the accessibility of all concealed valves, controls, equipment, etc.
Thermal insulation for mechanical room ceilings.	P				
Heating Convector Enclosure	P				HVAC Contractor shall provide list of enclosure locations and physical dimensions
Fin-tube Radiation Enclosure	P				HVAC Contractor shall provide list of enclosure locations and physical dimensions
Catwalks to mechanical equipment.	P				Supplying list of locations where required included in HVAC.
Ladders to mechanical equipment other than cooling towers	P				Supplying list of locations where required included in HVAC.

Item	Oth	Plb	Htg	Elec	Notes
Ladders to roof mounted AC units and HVAC equipment.			P		Coordinate with Architect and Structural Engineer.
Steel dunnage for roof mounted AC units and HVAC equipment other than cooling towers.			P		Coordinate with Architect and Structural Engineer.
Rubbish removal			P		Where one trade furnishes and another installs, the installing trade removes the shipping and packing materials which accumulate.
Special tools for equipment maintenance.			F		Special tools are defined as tools proprietary to a particular type or piece of equipment.
Electric duct heaters (heaters installed in air ducts).			P		Line connections included in electric. Drawings delineate exceptions.
Electric heaters with integral fans (cabinet heaters, unit heaters and the like).			P		Line connections included in electric. Drawings delineate exceptions.
Electric radiators (baseboard, sill line, and convector type heaters).				P	
Electric heater cables for radiant space heating.				P	
Electric heater cables for pipe tracing.				P	Line and control connections and control device mounting included in electric.
Access platforms for roof mounted AC units			P		Manufacturer to design access platforms with all associated structural elements to be furnished and installed by the HVAC contractor.

D. The Heating, Ventilating and Air Conditioning Contractor is required to supply all necessary supervision and coordination information to any other Contractors who are to supply work to accommodate the Heating, Ventilating and Air Conditioning installations.

E. Where the Heating, Ventilating and Air Conditioning Contractor is required to install items which it does not purchase, it shall include for such items:

1. The coordination of their delivery.

2. Their unloading from delivery trucks driven to any designated point on the property line at grade level.

3. Their safe handling and field storage up to the time of permanent placement in the project.

4. The correction of any damage, defacement or corrosion to which they may have been subjected.

5. Their field assembly and internal connection as may be necessary for their proper operation.

6. Their mounting in place including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt them to architectural and structural conditions.

7. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

F. Items which are to be installed, but not purchased as part of the work of the Division 23, shall be carefully examined by this Contractor upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of Division 23 will be considered only if presented in writing within one week of the date of delivery to the project of the items in question. The work of this Contractor shall include all procedures, regardless of how extensive, necessary to put into satisfactory operation, all items for which no claims have been submitted as outlined above.

1.16 DEFINITIONS

A. Specific items of terminology, as used herein or on drawings, shall have the following meanings.

1. "Piping"----------Pipe, fittings, flanges, valves, controls, hangers, traps, drains, insulation, vents, and items customarily required in connection with the transfer of fluids.

2. "Concealed"----------Embedded in masonry or other construction, installed behind wall furring, within double partitions or hung ceilings, in crawl spaces, in shafts.

3. "Exposed"----------Not concealed.

4. "By Other Trades" or "Others" or "Oth"-------By persons or parties responsible for work at the project other than the party or parties who have been duly awarded the contract for the work of Division 23. In the event that this document is used to acquire work as part of a general construction contract the words "by other trades" shall mean by persons or parties who are not anticipated to be the sub-contractor for Division 23 working together with the general contractor. In this context the words "by other trades" shall <u>not</u> be interpreted to mean not included in the overall contract.

5. Where reference is made to N.E.M.A. Standards, it shall be understood that this reference is to the "Approved Standards", published by the National Electrical Manufacturers Association, Main Office - 155 East 44th Street, New York, New York 10017.

6. Where reference is made to "A.N.S.I. Standards", it shall be understood that this reference is to the standards published by the American National Standards Institute Incorporated.

1.17 INTERPRETATION OF THE DRAWINGS AND SPECIFICATIONS

A. As used in the drawings and specifications, certain non technical words shall be understood to have specific meanings as follows:

1. "Furnish"----------Purchase and deliver to the project site complete with every necessary appurtenance and support.

2. "Install"----------Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project.

3. "Provide"----------"Furnish" and "Install".

B. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.

C. It shall be understood that the specifications and drawings are complementary and are to be taken together for a complete interpretation of the work. Where there are conflicts between the drawings and specifications or within the specifications or drawings themselves, the items of higher standard shall govern.

D. No exclusions from, or limitations, in the language used in the drawings or specifications shall be interpreted as meaning that the appurtenances or accessories necessary to complete any required system or item of equipment are to be omitted.

E. The drawings of necessity utilize symbols and schematic diagrams to indicate various items of work. Neither of these have any dimensional significance nor do they delineate every item required for the intended installations The work shall be installed, in accordance with the diagrammatic intent expressed on the electrical and mechanical drawings, and in conformity with the dimensions indicated on final architectural and structural working drawings and on equipment shop drawings and in accordance with the contractor’s coordination drawings.

F. No interpretation shall be made from the limitations of symbols and diagrams that any elements necessary for complete work are excluded.

G. Certain details appear on the drawings which are specific with regard to the dimensioning and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the indicated work.

H. Information as to the general construction shall be derived from structural and architectural drawings and specifications only.

I. The use of words in the singular shall not be considered as limiting where other indications denote that more than one item is referred to.

J. In the event that extra work is authorized, and performed by this trade, work shown on drawings depicting such work, and/or described by Bulletin is subject to the base building specifications in all respects.

1.18 EXAMINATION OF SITE AND CONTRACT DOCUMENTS

A. Before submitting prices or beginning work, thoroughly examine the site and the Contract Documents.

B. No claim for extra compensation will be recognized if difficulties are encountered which examination of site conditions and Contract Documents prior to executing Contract would have revealed.

1.19 WORKMANSHIP

A. The entire work provide in this Specification shall be constructed and finished in every aspect in a workmanlike and substantial manner.

B. It is not intended that the Drawings shall show every duct, pipe, fitting, equipment and appliance. HVAC Contractor shall furnish and install all such parts as may be necessary to complete the systems in accordance with the best trade practice.

C. Keep other trades fully informed as to shape, size and position of all openings required for apparatus and give full information to the General Contractor and other trades in a timely manner so that all opening may be built in advance. Furnish and install all sleeves, supports and the like as specified or as required.

D. In case of failure on the part of the HVAC Contractor to give proper and timely information as required above, he shall do his own cutting and patching or have same done by the General Contractor, but in any case, without extra expense to the Owner.

E. Obtain detailed information from the manufacturers of apparatus as to the proper method of installing and connecting same. Obtain all information from the General Contractor and other trades which may be necessary to facilitate work and completion of the whole project.

PART 2 – PRODUCTS

(Not Applicable)

PART 3 - EXECUTION

3.1 OPERATING INSTRUCTIONS

A. After all final tests and adjustments have been completed, fully instruct the proper Owner's Representative in all details of operation for equipment installed. Supply qualified personnel to operate equipment for sufficient length of time to assure that Owner's Representative is properly qualified to take over operation and maintenance procedures. Supply qualified personnel to operate equipment for sufficient length of time as required to meet all governing authorities in operation and performance tests.

3.2 GUARANTEES AND CERTIFICATIONS

A. All work shall be guaranteed to be free from leaks or defects. Any defective materials or workmanship as well as damage to the work of all trades resulting from same shall be replaced or repaired as directed for the duration of stipulated guaranteed periods.

B. The duration of guarantee periods following the date of beneficial use of the system shall be one year. Beneficial use is defined as operation of the system to obtain its intended use. For example, in the case of refrigeration systems, it means that the plant has a cooling load. Similarly, for all other systems.

C. The date of acceptance shall be the date of the final payment for the work or the date of a formal notice of acceptance, whichever is earlier.

D. Non-durable replaceable items such as air filter media do not require replacement after the date of acceptance. If received in writing, requests to have earlier acceptance dates established for these items will be honored.

E. Certification shall be submitted attesting to the fact that specified performance criteria are met by all items of heating and air conditioning equipment.

3.3 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Division 02 through Division 33 for rough-in requirements.

3.4 MECHANICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate mechanical systems, equipment, and materials installation with other building components.

2. Verify all dimensions by field measurements.

3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.

4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

7. Coordinate connection of mechanical systems with overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.

9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

10. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

11. Install access panel or doors for maintenance or inspection where units are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Sections titled “Access Doors and Frames” and Security Access Doors and Frames and a subsequent paragraph of this Section of Division 23.

12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.5 PROTECTION AND CLEANING

A. It shall be this trade's responsibility to store his materials in a manner that will maintain an orderly clean appearance. If stored on-site in open or unprotected areas, all equipment and material shall be kept off the ground by means of pallets or racks and covered with tarpaulins.

B. The inlet and discharge openings of all fan coil, and other terminal units shall be kept covered until all local plastering, parging, etc. is completed, and the units are ready to run. The inlet and discharge openings of fans, air handling, Roof Mounted Air Conditioning, pumps, etc. shall be kept covered until connected to system.

C. Equipment and material if left in the open and damaged shall be replaced, repainted, or otherwise refurbished at the discretion of the owner. Equipment and material is subject to rejection and replacement if in the opinion of the engineer, or in the opinion of the manufacturer's engineering department, the equipment has deteriorated or been damaged to the extent that its immediate use is questionable, or that its normal life expectancy has been curtailed.

D. During the erection protect all ductwork, duct lining, insulation, piping, and equipment from damage and dirt. Cap the open top and bottom of all ductwork and piping installed.

E. After completion of project, clean the exterior surface of all equipment included in this division of work including, but not limited to, concrete residue.

3.6 FLUSHING AND CLEANING OF PIPING

A. All piping systems shall be thoroughly flushed out with the approved cleaning chemicals to remove pipe dope, slushing compounds, cutting oils, and other loose extraneous materials. This also includes any piping systems which are not listed as requiring water treatment.

B. Develop plan for flushing and cleaning piping. Submit plan for approval prior to completion of piping. Provide all temporary and permanent piping, equipment, materials necessary to complete flushing and cleaning.

C. Prior to flushing, temporarily remove, isolate or bypass dirt sensitive equipment and devices.

D. Provide temporary pumps and piping to flush and chemically clean piping at a minimum velocity of 6 fps without using the system pumps.

E. Prior to flushing, install fine mesh construction strainers at inlet to all equipment with connections 2 1/2" and larger. Install fine mesh construction element in permanent strainers. During flushing and cleaning, remove and clean strainers periodically. At completion of final flush, clean permanent strainers, remove construction strainers.

F. Flush all piping with cold water for a minimum of 6 feet per second for one hour, until water runs clear. Water supply shall be equivalent to piping to be flushed. Drain all low points.

G. Circulate flush water and clean strainers prior to installing cleaning chemicals. Provide cleaning chemicals, under the direction of the chemical supplier. Following flushing, install cleaning chemicals and circulate through the entire system for a minimum of one hour, or as directed by chemical supplier. Take water sample for owner's use. Drain system, including all low points.

H. Flush, drain and fill system, circulate for one hour, sample for owner's use. Drain, flush, fill, circulate and sample until system is free of cleaning chemicals, as indicated by analysis of samples.

I. The cleaning chemicals shall be added by the mechanical trade. The chemical supplier shall verify that the chemicals are compatible with all the materials in the systems. The chemical supplier shall instruct as to the proper feed rates, shall check that the cleaning solution is actually in each system, shall instruct the contractor as to when to flush the system and shall check each system following flushing to ensure all cleaning chemicals have been removed from each system.

J. A certificate of cleaning shall be provided by the cleaning chemical supplier to the Architect's representative.

3.7 FIRE AND SMOKE DETECTION

A. Fire and smoke detection system will be provided and installed as part of the work of Division 26. The Contractor responsible for the work of Division 23 shall provide suitable openings (as recommended by the Smoke Detection System Manufacturer) in sheet metal for sensing elements.

B. The Contractor responsible for the work of Division 23 shall provide access doors to make all such detection heads accessible.

C. The Contractor responsible for the work of Division 23 shall provide bracing for smoke detection sampling tubes which exceed 48" in length.

3.8 DRIVE GUARDS

A. For all machinery and equipment (whether factory fabricated or field installed) provide OSHA approved guards for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor.

B. Materials: Sheet steel, cast iron, expanded metal or heavy gauge wire mesh rigidly secured so as to be removable without disassembling pipe, duct, or electrical connections to equipment.

C. Access for Speed Measurement: One inch diameter hole at each shaft center.

3.9 TOOLS AND LUBRICANTS

A. Furnish special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.

B. Lubricants: A minimum of one quart of oil, and one pound of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

3.10 PAINTING AND FINISHING

A. Refer to Division 09 titled "Finishes" for painting requirements.

B. Damage and Touch Up: Repair marred and damaged factory painted finishes with materials and procedures to match original factory finish.

C. Provide prime coat painting for the following if not provided with factory applied corrosion protection.

1. Miscellaneous steel and iron provided by Contractor responsible for the work of Division 23.

2. Hangers and supports iron provided by Contractor responsible for the work of Division 23.

3. Miscellaneous steel and iron provided by Contractor responsible for the work of Division 23 installed outdoors shall be provided with finished coats of exterior paint in accordance with requirements of Division 09 titled “Finishes” in addition to prime coat.

3.11 ACCESS DOORS IN FINISHED CONSTRUCTION

A. Access doors as required for operation and maintenance of concealed equipment, valves, controls, etc. will be provided as part of the work of Division 08.

B. This Contractor is responsible for access door location, size and its accessibility to the valves, controls, equipment, etc. being served.

C. Coordinate and prepare a location, size, and function schedule of access doors required and deliver to a representative of the Contractor for Division 08.

D. Furnish and install distinctively colored buttons in finished ceiling.

E. Access doors shall be of ample size to perform proper maintenance on concealed equipment, valves, controls, etc. but shall not be less than a minimum of 18" x 18".

F. Construct doors and frames to comply with the requirements of the NFPA and Underwriters Laboratories Inc. for fire rating. Install UL label on each door in a non-exposed location unless otherwise required by the local authority having jurisdiction.

A. This Contractor shall furnish access doors as required for operation and maintenance of concealed equipment, valves, controls, etc., and coordinate their delivery with the Contractor for Division 08. Installation of doors will be by the Contractor for Division 08 , but this Contractor shall locate the doors on approved shop drawings and shall be held responsible for the accessibility of all concealed valves, controls, equipment, etc. The delivery point for the access doors shall be where designated by the Construction ManagerGeneral ContractorOwner’s Representative, who shall coordinate the time of delivery with the Contractors involved

B. Coordinate and prepare a location, size, and function schedule of access required and deliver to a representative of the Contractor for Division 08.

C. Furnish and install distinctively colored buttons in finished ceiling.

D. Access doors shall be of ample size to perform proper maintenance on concealed equipment, valves, controls, etc. but shall not be less than a minimum of 18" x 18".

E. Access doors shall be as manufactured by Karp Associates, Inland Steel Products "Milcor" or other approved in accordance with the following schedule:

LOCATION	TYPE	CATALOG NUMBER
Wall and Ceiling	Recessed Door Panel for Plaster Recessed Door Panel for Drywall	Karp DSC-210-PL Milcor Style AP Karp RDWPD Milcor Style DWR
Acoustic Tile Ceiling	Recessed Door Panel for Tile	Karp DSC-210-AT Milcor Style AT
Wall and Ceiling	Non-Recessed Door Panel for Plaster	Karp DSC-214 PL Milcor Style K
Wall and Ceiling	Non-Recessed Door Panel for Drywall	Karp KDW Milcor Style DW
Ceramic Tile Walls	Non-Recessed Door Panel	Karp DSC-214-M Milcor Style M
Masonry Wall	Non-Recessed Door Panel	Karp DSC-214-M Milcor Style M

F. Doors and frames to be given a factory prime coat of corrosion resistant paint.

G. Frames shall be steel minimum gauge per manufacturer's standard gauge for model listed, welded mitered corners ground smooth with anchors.

H. Doors shall be steel minimum gauge per manufacturer's standard gauge for model listed, heavy hinges flush with frame, invisible when closed.

A. This Contractor shall furnish access doors as required for operation and maintenance of concealed equipment, valves, controls, etc., and coordinate their delivery with the Contractor for Division 08. Installation of doors will be by the Contractor for Division 08, but this Contractor shall locate the doors on approved shop drawings and shall be held responsible for the accessibility of all concealed valves, controls, equipment, etc. The delivery point for the access doors shall be where designated by the Construction ManagerGeneral ContractorOwner's Representative, who shall coordinate the time of delivery with the Contractors involved.

B. Coordinate and prepare a location, size, and function schedule of access required and deliver to a representative of the Contractor for Division 08.

C. Furnish and install distinctively colored buttons in finished ceiling.

D. Access doors shall be of ample size to perform proper maintenance on concealed equipment, valves, controls, etc. but shall not be less than a minimum of 18" x 18".

E. The doors shall be as follows:

1. Non-rated access doors as required for non-rated wall, partitions and ceiling construction.

2. Doors shall be complete with mortise cylinder locks, steel piano hinges with stainless steel pin, anchors, and a prime coat of corrosion resistant, factory applied, paint. All frames for access doors shall be of design suitable for the construction into which it will be installed.

3. Construction - Doors shall be factory made, flush metal construction of not less than No. 16 gauge metal thickness for frames, and door panels not less than 20 gauge. Frames shall be of welded construction with mitered corners. All welds shall be ground smooth. Hinges shall be flush with frame, invisible when door is closed.

4. Access doors shall be recessed or non-recessed type as selected by Architect.

5. See Division 08 for additional access door requirements.

3.12 PRE-OCCUPANCY SPACE FLUSH OUT

A. At completion of construction, prior to turn over of the building, the contractor shall conduct a pre-occupancy flush out of the system as follows:

1. All supply air systems shall be run at 100% fan capacity for a period of two weeks. For systems with return air fans, fan shall run at 100% fan capacity.

2. During the flush out, all outside air dampers shall be locked into the 100% outside air position. Return air dampers shall be fully closed and all spill air dampers shall be 100% open. Exhaust fans shall be operated at 100% exhaust.

3. Cooling and/or heating coil valves shall be controlled by the building management system to provide properly tempered and dehumidified air.

a. Supply air temperature shall be set to provide a maximum space temperature of 78°F, minimum space temperature of 66°F and a maximum space humidity of 60% RH.

4. All exhaust fans that are required to run to maintain proper building pressurization shall be operated at 100% fan capacity for the flush out period.

3.13 REFRIGERANT HANDLING

A. Refrigerant Installation and Disposal: Perform all work related to refrigerant contained in chillers, cooling coils, air conditioners, and similar equipment, including related piping, in strict accordance with the following requirements:

1. ASHRAE Standard 15 and Related Revisions: Safety Code for Mechanical Refrigeration.

2. ASHRAE Standard 34 and Related Revisions: Number Designation and Safety Classification of Refrigerants.

3. United States Environmental Protection Agency (US EPA) requirements of Section 808 (Prohibition of Venting and Regulation of CFC) and applicable State and local regulations of authorities having jurisdiction.

B. Recovered refrigerant is the property of the Contractor. Dispose of refrigerant legally, in accordance with applicable rules and regulations of authorities having jurisdiction.

END OF SECTION 23 05 00
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SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

B. Related Sections

1. Division 23 Section 230547 Vibration Controls for Mechanical and Electrical Systems (Non-Seismic)
2. Division 23 Section 230514 Enclosed Controllers
3. Applicable Sections of Division 26 PRODUCTS

1.3 DEFINITIONS

A. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

B. Field-Installed Motor: A motor installed at Project site and not factory installed as an integral component of motorized equipment.

1.4 SUBMITTALS

A. Product Data for Field-Installed Motors: For each type and size of motor, provide nameplate data and ratings; shipping, installed, and operating weights; mounting arrangements; size, type, and location of winding terminations; conduit entry and ground lug locations; and information on coatings or finishes.

B. Shop Drawings for Field-Installed Motors: Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:

1. Each installed unit's type and details.
2. Nameplate legends.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain field-installed motors of a single type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70, as amended by state and local codes.

D. COORDINATION

1. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:

2. Compatible with the following:

a. Magnetic controllers.
b. Multispeed controllers.
c. Reduced-voltage controllers.

3. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
4. Matched to torque and horsepower requirements of the load.
5. Matched to ratings and characteristics of supply circuit and required control sequence.
6. Motor compatible with ambient and environmental conditions of motor installation

E. Coordinate motor support with requirements for driven load; access for maintenance and motor replacement; installation of accessories, belts, belt guards; and adjustment of sliding rails for belt tensioning.

F. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section.

PART 2 - PRODUCTS

2.1 MOTOR REQUIREMENTS

A. Motor requirements apply to factory-installed and field-installed motors except as follows:

1. Different ratings, performance, or characteristics for a motor are specified in another Section.
2. Manufacturer for a factory-installed motor requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.

2.2 MOTOR CHARACTERISTICS

A. Motors ½ HP and Larger: Three phase.

B. Motors Smaller Than ½ HP: Single phase.

C. Frequency Rating: 60 Hz.

D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.

E. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

F. Duty: Continuous duty at ambient temperature of 105 deg F (40 deg C) and at altitude of 3300 feet (1005 m) above sea level.

G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

H. Enclosure: Open dripproof.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design E, medium induction motor. Efficiency in accordance with NEMA standards for Premium Efficient motors and with applicable EPACT Efficiency Standards.

B. Stator: Copper windings, unless otherwise indicated.

1. Multispeed motors shall have separate winding for each speed.

C. Rotor: Squirrel cage, unless otherwise indicated.

D. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading.

E. Temperature Rise: Match insulation rating, unless otherwise indicated.

F. Insulation: Class F, unless otherwise indicated.

G. Code Letter Designation:
1. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

H. Enclosure: rolled steel for motors smaller than 7.5 hp.

1. Finish: Gray enamel.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: copper magnet with moisture-resistanceinsulation varnish, designed and tested to resist spikes, high frequency and short time rise pulses produced by pulse-width modulated inverts.
2. Provide a maintenance free, circumferential, conductive micro fiber shaft grounding ring (Aegis Bearing Protection Ring or similar) on the AC motor to discharge shaft currents to ground. For motors 100 horsepower or less, provide a shaft ground ring on either the drive end or non-drive end in accordance with the manufacturer's recommendations.
3. Designed with critical vibration frequencies outside operating range of controller output.
4. Temperature Rise: Matched to rating for Class B insulation.
5. Insulation: Class H.
6. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
7. Inverter rated: Comply with NEMA MG-1 Part 31.4.4.2 requirements for inverter rated motors.

C. Severe/Rugged-Duty Motors: Comply with IEEE841, totally enclosed, with 1.25 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings insulated with nonhygroscopic material.

1. Finish: Chemical-resistant paint over corrosion-resistant primer.

2.5 SINGLE-PHASE MOTORS

A. Type: One of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split-phase start, capacitor run.
3. Capacitor start, capacitor run.
4. Shaded-Pole Motors: For motors 1/20 hp and smaller only.

B. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

C. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, prelubricated-sleeve type for other single-phase motors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive field-installed motors for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of conduit systems to verify actual locations of conduit connections before motor installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 MOTOR INSTALLATION

A. Anchor each motor assembly to base, adjustable rails, or other support, arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and align with load transfer link.

B. Install motors on concrete bases complying with Division 03.

C. Comply with mounting and anchoring requirements specified in Division 23.

3.3 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
2. Test interlocks and control features for proper operation.
3. Verify that current in each phase is within nameplate rating.

B. Testing: Perform the following field quality-control testing:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.15.1. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.4 ADJUSTING

A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.5 CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean motors, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 23 05 13

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SECTION 23 05 14 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:

1. Full-voltage manual.
2. Full-voltage magnetic.
3. Reduced-voltage magnetic.
4. Multispeed.

B. Related Section:
1. Division 26 Installation of Enclosed Controllers
2. Division 26 Selection of Overcurrent Devices for OCD's and disconnect switches for use with motor controllers.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. OCPD: Overcurrent protective device.

G. SCR: Silicon-controlled rectifier.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.

1. Show tabulations of the following:

a. Each installed unit's type and details.
b. Factory-installed devices.
c. Nameplate legends.
d. Short-circuit current rating of integrated unit.
e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.

2. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field quality-control reports.

C. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

D. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and installed components.
2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
3. Manufacturer's written instructions for setting field-adjustable overload relays.
4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

1.7 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.

4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70 as amended by state and local codes.

C. Listing and Labeling: Provide products specified in this section that are Underwriters Laboratories listed and labeled.

1. The terms "listed" and "labeled" shall be as they are in the National Electrical Code, Article 100.

D. Single Source Responsibility: Obtain similar motor control devices from a single manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).

2. Altitude: Not exceeding 6600 feet (2010 m).

1.11 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

D. Coordinate features of enclosed controllers and accessories with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories and functions with rating and characteristics of supply circuits, required control sequences and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
c. Rockwell Automation, Inc.; Allen-Bradley brand.
d. Siemens Energy & Automation, Inc.
e. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing, Reversing or Two speed.
3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 20 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
4. Flush or Surface mounting.
5. Red or Green pilot light.
6. Additional Nameplates: HIGH and LOW for two-speed controllers.

C. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
c. Rockwell Automation, Inc.; Allen-Bradley brand.
d. Siemens Energy & Automation, Inc.
e. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing.

3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 20 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type.
4. Flush or Surface mounting.
5. Red or Green pilot light.
6. N.O. and N.C. auxiliary contact.
7. Low voltage protection.

D. Magnetic Controllers: Full voltage, across the line, electrically held.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
    c. Rockwell Automation, Inc.; Allen-Bradley brand.
    d. Siemens Energy & Automation, Inc.
    e. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing or Reversing.
3. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.

    a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

    a. CPT Spare Capacity: 100%.

6. Bimetallic Overload Relays:

    a. Inverse-time-current characteristic.
    b. Class 20 tripping characteristic.
    c. Heaters and sensors in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
    d. Ambient compensated.

7. N.C. and N.O., isolated overload alarm contact.
8. External overload reset push button.

E. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   c. Rockwell Automation, Inc.; Allen-Bradley brand.
   d. Siemens Energy & Automation, Inc.
   e. Square D; a brand of Schneider Electric.

2. Fusible Disconnecting Means:

   a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with rejection - type fuse clips for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a Nationally Recognized Testing Laboratory.
   b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

3. Circuit-Breaker Disconnecting Means:

   a. NEMA AB 1, motor-circuit protector with field- adjustable, short-circuit trip coordinated with motor locked-rotor amperes
   b. Lockable Handle: accepts three padlocks and interlocks with cover in closed position.

4. Nonfusible Disconnecting Means:

   a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
   b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

5. MCCB Disconnecting Means:

   a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
   b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   d. N.C. and N.O. alarm contact that operates only when MCCB has tripped. Quantity as required.

6. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

2.2 REDUCED-VOLTAGE MAGNETIC CONTROLLERS

A. General Requirements for Reduced-Voltage Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A; closed-transition; adjustable time delay on transition.

B. Reduced-Voltage Magnetic Controllers: Reduced voltage, electrically held.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   c. Rockwell Automation, Inc.; Allen-Bradley brand.
   d. Siemens Energy & Automation, Inc.
   e. Square D; a brand of Schneider Electric.

2. Configuration:

   a. Star-Delta Controller: NEMA ICS 2, closed transition with adjustable time delay, four contactors, with a three-phase starting resistor/reactor bank.
   b. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition, medium-duty service, with integral overtemperature protection; taps for starting at 50, percent of line voltage; two START and one RUN contactors.

3. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.

   a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

   a. CPT Spare Capacity: 100 percent.

6. Bimetallic Overload Relays:

   a. Inverse-time-current characteristic.
   b. Class 20 tripping characteristic.
   c. Heaters and sensors in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
   d. Ambient compensated.

7. N.C. and N.O., isolated overload alarm contact.
8. External overload reset push button.

C. Combination Reduced-Voltage Magnetic Controller: Factory-assembled combination of reduced-voltage magnetic controller, OCPD, and disconnecting means.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   c. Rockwell Automation, Inc.; Allen-Bradley brand.
   d. Siemens Energy & Automation, Inc.
   e. Square D; a brand of Schneider Electric.

2. Fusible Disconnecting Means:

   a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with rejection type fuse clip, for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a Nationally Recognized Testing Laboratory.
   b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

3. Circuit-Breaker Disconnecting Means:

   a. NEMA AB 1, motor-circuit protector with field- adjustable, short-circuit trip coordinated with motor locked-rotor amperes
   b. Lockable Handle: accepts three padlocks and interlocks with cover in closed position.

4. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

5. Nonfusible Disconnecting Means:

   a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
   b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.

6. MCCB Disconnecting Means:

   a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
   b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
   d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
   e. N.C. and N.O. alarm contact that operates only when MCCB has tripped. Quantity as required.

2.3 RATINGS

A. Controllers bear UL short Circuit rating of 100,000 amps with appropriate line side fuses on a series rated basis and labeled accordingly

2.4 WIRING

A. All wiring within controllers shall be copper.

2.5 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: NEMA 250 Type 1.
2. Outdoor Locations: NEMA 250, Type 3R .
3. Other Wet or Damp Indoor Locations: NEMA 250 Type 4.

B. Covers are interlocked with disconnecting means.

2.6 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty type.

a. Push Buttons: Recessed types; momentary as indicated.
b. Pilot Lights: LED types; colors as indicated; push to test.
c. Selector Switches: Key-operated with key removable only “Remote” or “Auto” position as applicable.

B. Reversible N.C./N.O. auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Relays: Provide auxiliary and adjustable time-delay relays as follows:

1. Auxiliary control circuit relay for each magnetic controller NEMA Size 1 and larger, arranged to prevent holding coil currents into the external control circuit.
2. Phase-failure and undervoltage relay for each magnetic controller size 5 and larger. Adjustable undervoltage setting.
3. Undervoltage lockout relay for magnetic controllers where so indicated on drawings.

E. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in Type 3Renclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

H. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

I. Cover gaskets for Type 1 enclosures.

J. Terminals for connecting power factor correction capacitors to the load side of overload relays.

K. Spare control wiring terminal blocks, quantity as indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of motor controllers will be performed as part of the work of Division 26 (Electrical).

B. Installation of motor control devices will be performed as part of the work of Division 23.

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

C. Use fractional-horsepower manual controllers for single-phase motors, unless otherwise indicated.

D. Hand-Off-Automatic (and Hand-Off-Remote) Selector Switches: Except as otherwise indicated, factory install in covers of manual and magnetic controllers of motors started and stopped by central control system and/or automatic controls or interlocks with other equipment. Make control connections so only the manual and automatic control devices that have no safety functions will be bypassed when the switch is in the hand position. Connect motor control circuit in both hand and automatic positions for safety type control devices such as low - and high - pressure cutouts , high temperature cutouts, and motor overload protectors. Switches are of the key-operated cylinder lock type, with key removable only in auto (remote) position. All locks are keyed alike.

E. Pushbutton Stations: Except as otherwise indicated, momentary-contact, start-stop units. Provide in covers of magnetic controllers for manually started motors where indicated, and connect start contact in parallel with sealing auxiliary contact for low voltage protection.

3.3 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed.

END OF SECTION 23 05 14

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SECTION 23 05 17 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.

2. Stack-sleeve fittings.

3. Sleeve-seal fittings.

4. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral 2" all-around waterstop continuously welded to sleeve.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends with a ¼ inch steel plate continuously welded to outside of pipe 2 inch all-around waterstop collar and zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 16" Gauge minimum thickness; round tube closed with welded longitudinal joint.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

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

1. Smith, Jay R. Mfg. Co.

2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL FITTINGS

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

1. Presealed Systems.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by removable molded-PE or -PP sleeves.

2. Cut sleeves to length for mounting flush (including Floor Finishes) with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas/rooms or other wet areas 2 inches (50 mm) above finished floor level.

b. For Roof construction, equal to depth of roof construction plus roof insulation.

3. Seal annular space between sleeve and piping or piping insulation use joint sealants appropriate for size, depth and location. Comply with requirements for sealants specified in Section 079200 “Joint Sealant”

4. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

C. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.

2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.

2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."

3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.

4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

5. Using grout, seal the space around outside of stack-sleeve fittings.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

a. Piping Smaller than NPS 6 (DN 150): Galvanized-steel wall sleeves.

b. Seal annular opening between sleeve and pipe or pipe insulation with appropriate joint sealant that makes opening water-tight and air tight.

2. Concrete Slabs above Grade:

a. Piping Smaller than NPS 6 (DN 150) Galvanized-steel-pipe sleeves

b. Concrete floors, walls and roofs with membrane waterproofing and non-membrane floors, walls and roofs where flashing is required, stack-sleeve fittings shall be used.

3. Interior Partitions:

a. Piping Smaller than NPS 6 (DN 150) Galvanized-steel-sheet sleeves.

END OF SECTION 23 05 17

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SECTION 23 05 18 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough brass finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed exposed-rivet hinge, and spring-clip fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening. Provide Close Fitting Escutcheons on both sides of piping (whether exposed or not) passing through required Floors, Partitions and Ceilings.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.

c. Insulated Piping: One-piece, Cast-Brass type or split, casting Brass type with concealed hinge.

d. Bare Piping at Wall in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.

e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.

f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with Rough Brass finish.

g. Bare Piping in Equipment Rooms: One-piece, cast-brass split-casting brass type with rough-brass finish.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 23 05 18

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SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Ball valves.

2. Check valves.

3. Center-guided check valves. Gate valves.

B. Related Sections:

1. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

a. Other related sections of Division 23.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

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

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

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

B. Submit manufacturer's certification that the valve's pressure and temperature rating meets the systems working pressure and temperature requirements.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source same manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.1 for power piping valves.

3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set gatevalves closed to prevent rattling.

4. Set ball valves open to minimize exposure of functional surfaces.

5. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

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

C. Valve Manual Actuator Types:

1. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.

D. Valves in Insulated Piping: Provide 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.

2. Ball Valves: With 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. Solder Joint: With sockets according to ASME B16.18.

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

2.2 BRONZE BALL VALVES (SEE SECTION "D" BALL VALVE NOTES)

A. Two-Piece, - Standard Port, Bronze Ball Valves with Bronze Trim: (Type A).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves. Series 70-100 (threaded); 70-200 (solder)

b. Crane Co.; Crane Valve Group; Crane Valves.

c. A division of Advanced Thermal Systems, Inc.

d. Milwaukee Valve Company. BA-100 (threaded); BA-150 (solder)

e. NIBCO INC. T-585-70 (threaded); S-585-70 (solder)

2. Standard: MSS SP-110 Description:

a. Valve size ½' thru 3"

B. 3-Piece Full Port Bronze Ball Valve Solder End (In-Line Serviceable Valve) with Bronze Trim for Copper Pipe Systems (Type AB)

1. Manufacturers: Subject to compliance with requirements, provide product by:

a. Conbraco Industries Inc.: Apollo Valve 82-200 Series, Valve size 3/8" to 4"

b. Milwaukee Valve Company: BA-350 Series, Valve size 3/8" to 3"

2. Description:

a. Standard ISO 9001-2008; MSS SP-110

b. For brazed installations or 95/5 solder

c. Valve size: 3/8" to 4"

d. CWP: 600 psi; SWP: 150 psi Series 82-200

e. CWP: 400 psi: SWP: 150 psi (82-240 Series 316 SS Ball & Stem)

C. Ball Valve Notes Typical for Hydronic ball valves Type A and Type AB.

1. Provide 2-1/4" stem extension for valve on insulated pipes.

2. Balancing stop for hydronic installations.

3. SWP Rating 150 psig @ 350F; CWP Rating 600 psig @150F.

4. 2 Piece 3" and smaller Ball valves in hydronic systems up to 200 F @ 200 psig and lower, and saturated steam systems up to a maximum 15 psig can be joined with 95/5 tin-antimony solder.

2.3 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc: (Type F).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.

b. Crane Co.; Crane Valve Group; Stockham Division. Figure B-319Y

c. Milwaukee Valve Company. Figure 509

d. NIBCO INC. Figure T-413-BY

e. Powell Valves. Figure 578

2. Description:

Standard: MSS SP-80,

SWP Rating: 125 psig @ 406˚F CWP Rating 200 psig @ 150˚F

Check Valve Size: ½" thru 3"

2.4 SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats: (Type H).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.

b. Crane Co.; Crane Valve Group; Stockham Division. Figure G-931, Bronze Trim (3" thru 24")

c. Milwaukee Valve Company. F2974 A Bronze Trim

d. NIBCO INC. Figure F-918 B, Bronze Trim

e. Powell Valves. Figure 559 w. Bronze Trim

2. Description:

a. Standard: MSS SP-71,

b. Check Valve Size: 3" thru 24" (Check Manufacturer Sizes)

2.5 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Iron, Full Face; Wafer, Center-Guided Silent Check Valves with Metal Seat: (Type K).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Stockham.

b. Milwaukee Valve Company.

c. Mueller Steam Specialty; a division of SPX Corporation. Model 101 MAP

2. Description:

a. Standard: MSS SP-125.

b. CWP Rating 200 psig @ 150˚F

c. Check Valve Size: 1" thru 3"

B. Class 125, Iron, Globe, Center-Guided Silent Check Valves with Metal Seat (Type L):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Milwaukee Valve Company.

b. Mueller Steam Specialty; a division of SPX Corporation. Model 105-MAP

c. Spence Strainers International; a division of CIRCOR International.

2. Description:

a. Standard: MSS SP-125.

Valve Size 3" thru 24"

CWP Rating:

3 inch thru 12 inch 200 psig @ 150˚F

14 inch thru 30 inch 150 psig @ 150˚F

b. Valve Design: Spring loaded; silent check; globe style

C. Class 150, RS Bronze Gate Valves: (Type O).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves. Figure B-120.

b. Milwaukee Valve Company. Figure 1151

c. NIBCO INC.

d. Powell Valves. Figure 2714

2. Description:

a. Standard: MSS SP-80, Type 2.

b. SWP Rating: 150 psig @ 406˚F

c. CWP Rating: 300 psig @ 150˚F End Connection Threaded

d. Valve Size 3/8" thru 3 inch

e. End Connection Threaded

2.6 IRON GATE VALVES

A. Class 125, OS&Y, Iron Gate Valves Bronze Trim: (Type Q).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.

b. Crane Co.; Crane Valve Group; Stockham Division Figure G-623 (3" – 24")

c. Milwaukee Valve Company. Figure 2885A (3" – 12")

d. NIBCO INC.

e. Powell Valves. Figure 1793 Class 125, (3" thru 24")

2. Description:

a. Standard: MSS SP-70, Type I.

b. End Connection: Flange

c. Valve Size 3 thru 24 inch (See valve manufacturer's size limitations)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damages.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.

3. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. Furnish and install valves shown on the drawings, specified herein and/or necessary for the control and easy maintenance of all piping and equipment. All valves shall be first quality of approved manufacture, shall have proper clearances, and shall be tight at the specified test pressure. Each valve shall have the maker's name or brand, the figure or list number and guaranteed ANSI working pressure cast on the body and cast or stamped on the bonnet, or shall be provided with other means of easy identification. All valves of one type (gate, ball, etc.) shall be the product of one manufacturer for that type of valve.

B. Valves shall be a minimum working pressure and materials as fittings specified for the service except as herein modified. All gate valves shall be suitable for repacking under pressure. Regardless of service, valves shall not be designated for less than 125 pounds per square inch steam working pressure.

C. Provide ball valves for shut-off wherever possible.

D. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball, butterfly valves.

2. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.

E. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

F. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2½ and Smaller: Threaded ends except where solder-joint valve-end option is required.

END OF SECTION 23 05 23

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SECTION 23 05 29 – HANGERS, SUPPORTS AND ACCESSORIES FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Pipe stands.
5. Equipment supports.

B. Related Sections:

1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Applicable Sections of Division 23.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design hangers and supports for piping and equipment in accordance with requirements in vibration section of Division 23 and obtain approval from authorities having jurisdiction.

1.5 ACTION SUBMITTALS

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

B. Shop Drawing Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Pipe stands.
3. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
4. Stainless steel hangers and pipe supports shall be used for piping located outdoors or indoors in area where systems are exposed to moisture environments.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel orstainless steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

B. Back to Back channel loads shall be limited to the following:

1. 3 inch (4.1#) – 2,900 lbs up to 36 inches center to center
2. 3 inch (4.1#) – 1,700 lbs over 36 inches center to center
3. 4 inch (5.4#) – 5,100 lbs up to 36 inches center to center
4. 4 inch (5.4#) – 3,000 lbs over 36 inches center to center

2.3 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support piping.

B. Coordinated pipe stands mounting for piping on roof with the roofing system requirements in Division 07 titled "Thermal and Moisture Protection.

C. Single Pipe Stand (axial movement ¼ inch or less)

1. Pipe stand for horizontal piping mounted from floor or roof
2. Pipe Size Base Pipe Support

   3 ½ inch or less 2 ½ inch

3. Provide base flange to mount pipe stand to floor or roof.
4. Mount pipe support equal to MSS-SP- For exterior mounted pipe supports, pipe support shall be stainless steel or provide with coating to prevent corrosion.
5. 69 Type 101 cast iron stand to vertical pipe support.

D. Single Pipe Stand (axial movement greater than ¼ inch)

1. Assembly frame from vertical pipes or steel channels with cross bracing and horizontal members to support pipe.
2. Horizontal member shall be adequately sized to accommodate the pipe support and the weight of the pipe and contents.
3. For roof mounted piping or exterior mounted pipe, pipe stand shall be provide with coatings to protected against corrosion
4. Mount pipe on pipe support equal to MSS-SP-69 Type 44 or MSS-SP-69 Type 46 if vertical adjustment is required.
5. For exterior mounted pipe supports, pipe support shall be stainless steel or provide with coating to prevent corrosion. See MSS-SP -58 for coating requirements Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

E. Multiple-Pipe Stand (axial movement ¼ inch or greater)

1. Assembly frame from vertical pipes or steel channels with cross bracing and horizontal members to support pipes.
2. Horizontal member shall be adequately sized to accommodate the pipe support.
3. For roof mounted piping or exterior mounted pipe, pipe stand shall be provided with coatings to protected against corrosion
4. Mount pipe on pipe support equal to MSS-SP-69 Type 44 or MSS-SP-69 Type 46 if vertical adjustment is required for each pipe.
5. For exterior mounted pipe supports, pipe support shall be stainless steel or provide with coating to prevent corrosion.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

1. Pipe supports for curb mounted piping shall be as outline in paragraphs C, D & E.

2.4 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.5 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Install hangers supports for piping and equipment in accordance with the requirements schedules in Parts 2 & 3 of this section.

B. In all cases, attachments to structure shall be review by the Structural Engineer. Loads and details of attachment to structure shall be submitted to structural engineer for coordination and approval.

C. All required supports, hangers, anchors, guides shall be provided and installed by this contractor. Shop drawings shall be submitted indicating the following.
1. Methods of hanging or supporting all mechanical equipment & piping furnished by this trade.

2. Insert locations intended for the hanging of any mechanical equipment shall note the weight to be hung from each insert.
3. Insert locations intended for the hanging of piping over 5" or equipment shall also note the weight to be hung from each typical insert.
4. Where other methods are used, beam clamps or fish plates, for example, weights shall be similarly shown.
5. Multiple piping whether by other trades or not, if included on a trapeze type hanger furnished by this trade shall similarly indicate weights.
6. Note that mechanical equipment is not limited to pipe connected equipment, but includes fans, coils, etc.
7. Although piping under 6" need not be shown, furnish information upon request at any time during the course of the installation.
8. The indication of weights will not be waived unless there is reason to accept a general statement, approved in writing by the Architect and/or the Structural Engineer.
9. The structural engineer must approve the method of hanging before work is commenced.

D. All pipe supports shall be of type and arrangement as shown on "Pipe Hanger and Support Schedule" on drawings and hereinafter specified. They shall be so arranged as to prevent excessive deflection and avoid excessive bending stresses between supports.

E. All bracket clamp and rod sizes indicated in this specification are minimum sizes only. This trade shall be responsible for structural integrity of all supports. All structural hanging materials shall have a safety factor of 5 built in.

F. For copper tubing, supports shall follow schedule and specifications. Supports for uncovered lines shall be especially designed for copper tubing, and shall be of exact O.D. diameter of tubing and shall be copper plated.

G. Roller type supports shall be used for pipes subject to axial movement. They shall be braced so that movement occurs in roller rather than support rods.

H. Provide shields at hangers for cold insulated piping and saddles welded to pipe at hangers for hot insulated piping.

I. Provide all steel required for support of pipes and equipment other than steel shown on structural engineer's drawings.

J. All hangers on piping including clevis hangers, rods, inserts, clamps, stanchions, brackets, shall be dipped in Zinc Chromate Primer before installation.

K. All pipe supports shall be designed to avoid interferences with other piping, hangers, electrical conduits and supports, building structures and equipment.

L. Pipe hangers shall be connected to building structure as follows:

Building Structure Type	Pipe Support Method
Poured concrete floor slabs.	Galvanized steel inserts and/or fishplates of sufficient area to support twice the calculated dead load.
Building Structure Steel.	Beam Attachments, etc.
Concrete slabs where piping revisions are required and approved after slabs are poured.	Piping 3" and smaller may be supported at intermediate points by Phillips, or other approved 3/4" expansion bolts and shields, provided main supports are welded to structural steel and such main supports are welded to structural steel and such main supports are not less than 20 feet on centers.

M. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

N. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

O. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. For roof mounted piping, coordinate mounting with requirements outlined in Division 07 titled “Thermal and Moisture Protection”.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section titled "Roof Accessories" for curbs.

P. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

Q. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

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

S. Install lateral bracing with pipe hangers and supports to prevent swaying.

T. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

V. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

W. Insulated Piping:

1. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
3. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor or roof.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

D. For roof mounted piping, coordinate mounting with requirements outlined in Division 07 titled “Thermal and Moisture Protection”

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal as required.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

B. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

D. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

E. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment and outdoor applications.

F. Use copper-plated pipe hangers and stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Piping Hangers and Supports: Install Pipe Hangers and Supports as per the following schedule:

PIPE HANGER SCHEDULE & ACCESSORIES					
Designation	MSS-SP-69 Designation	Manufacturer Model			Cosentini Figure Designation (See Note1)
		Carpenter & Patterson	F & M	Grinnell	
Clevis Hanger	Type 1	268	282		1,2 & 3
Clevis Roller Hanger	Type 43	100	239	93	4,5 & 6
Two Rod Roller Hanger	Type 41	142	170	95	7,8 & 9
Ridge Trapeze	Type 59	371	See Note 3	See Note 3	10, 11 & 12
Cast Iron Roller Stand	Type 44	17	160	271	20, 21 & 22
Adjustable Cast Iron Roller Stand	Type 46	53	161	274	20, 21 & 22
Adjustable Steel Pipe Stanchion	Type 38	101/101U	291 See/ Note 2	259 See Note 2	23,24 & 25
Welded Steel Bracket (Light)	Type 31	69	See Note 3	See Note 3	19
Welded Steel Bracket (Medium)	Type 32	84	See Note 3	See Note 3	19
Welded Steel Bracket (Heavy)	Type 33	139	See Note 3	See Note 3	19
Single Bolt Riser Clamp	Type 8	126	241	261	40, 41 & 42
Double Bolt Riser Clamp	Type 42	124	See Note 3	See Note 3	40, 41 & 42
Three Bolt Pipe Clamp	Type 3	304	261	295	29
U-Bolt	Type 24	283	176	137	13, 14, 15, 31 and 23, 24 & 25 where adjustable steel pipe stanchion 101U is required
Beam Clamp	-	268	282	See Note 3	
Welded Beam Attachment	Type 22	113 A	See Note 3	66	Upper Attachment

PIPE HANGER SCHEDULE & ACCESSORIES					
Designation	MSS-SP-69 Designation	Manufacturer Model			Cosentini Figure Designation (See Note1)
		Carpenter & Patterson	F & M	Grinnell	
Welded Beam Attachment w/Bolt and Nut	Type 22	113B	251	66	Upper Attachment
Insert	-	-	-	-	Upper Attachment
Continuous Slotted Insert	-	-	-	-	Upper Attachment
Metal Deck Ceiling Bolt		143			
Pipe Shield (120)	Type 40	265 P			Insulated Pipe with Vapor Barrier Jacket
Pipe Shield (180)	Type 40	265 P			Insulated Pipe with Vapor Barrier Jacket
Pipe Shield (360)	Type 40	265 P			Insulated Pipe with Vapor Barrier Jacket
Pipe Saddle	Type 39	351 thru 357Z	170 & 1700 Series	180 Series	Insulated Pipe

I. The following schedule shall be used for hanger spacing and hanger rod size.

1. Where piping system includes concentrated loads (valves, strainers, air separators, etc.), provide additional hangers on either side of the concentrated load
2. Maximum weights on hanger rods assuming a maximum operating temperature of 450˚F shall be such that stress in tension shall not exceed 9,000 psi using root area of threaded portion of rod.

3. Minimum rod size for pipe size shall not be less than the rod size indicated in schedule regardless of load.

Pipe Hanging Spacing & Hanger Rod Schedule for Steel Piping		
Pipe Size	Maximum Hanger Spacing (Feet)	Minimum Hanger Rod Size (Diameter)
1/2 "	5	3/8"
3/4"	6	3/8"
1" & 1 1/4	7	3/8"
1 1/2"	9	3/8"
2"	10	3/8"
2 1/2"	11	1/2"
3"	12	1/2"
Pipe Hanging Spacing & Hanger Rod Schedule for Copper Piping		
Pipe Size	Maximum Hanger Spacing (Feet)	Minimum Hanger Rod Size (Diameter)
3/4"	5	3/8"
1" & 1 1/4	6	3/8"
1 1/2"	7	3/8"
2"	8	3/8"
2 1/2"	9	1/2"
3"	10	1/2"

J. Pipe Stanchion supports for horizontal pipes shall be as follows:

Pipe Size	Stanchion Support
2 ½ & 3 inch	2 ½ inch

K. Hanger-Rod Attachments: The following suggested Hanger-Rod Attachments are for information only. Final selection of Hanger-Rod Attachments shall be by the HVAC Contractor.

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

L. Building Attachments: The following suggested Building Attachments are for information only. Final selection of Building Attachments shall be by the HVAC Contractor.

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam (MSS Type 20): For attaching to bottom flange of beams.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
10. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).

11. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
12. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
13. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

3.7 PANS AND DRAINS OVER ELECTRICAL EQUIPMENT

A. This contractor shall examine the drawings and in cooperation with the Electrical Trade confirm the final location of all electrical equipment to be installed in the vicinity of piping. Plan and arrange all overhead piping no closer than 6'-0" feet from a vertical line above electrical equipment, including but not limited to, main switchgear equipmentstarter, electric motors, switchboards, panelboards, or similar equipment. Piping is not permitted in Electric Equipment, Transformer, Switchgear, Elevator Equipment, Telephone Gear and Fire Pump Rooms.

B. Where the installation of piping does not comply with the requirements of the foregoing paragraph, where feasible the piping shall be relocated.

C. Furnish gutters as follows:

1. Provide and erect a gutter of 16 ounce cold rolled copper or 18 gauge galvanized steel, under every pipe which is within 6'-0" from a vertical line to any motor, electrical controllers, switchboards, panel boards, or the like.

2. Each gutter shall be reinforced, rimmed, soldered and made watertight, properly suspended and carefully pitched to a convenient point for draining. Provide a 3/4" drain, with valve as directed, to nearest floor drain or slop sink, as approved.

3. In lieu of such separate gutters, a continuous protecting drain pan of similar construction adequately supported and braced, properly rimmed, pitched and drained to a floor drain or suitable waste, may be provided over any such electrical equipment, and extending 3'-0" in all directions beyond the electrical equipment, over which such piping has to run.

3.8 CONCRETE BASES

A. Concrete bases (including reinforcing and forms) shall be provided by the Contractor responsible for the work of Division 03.

B. Concrete bases shall be adequate to suit the footprint of the equipment but not less than 4 inches larger than the unit supported in both direction.

C. Concrete bases shall be a minimum of 4 inches high unless otherwise noted

D. HVAC Contractor (Work of Division 23) shall furnish shop drawings showing adequate concrete reinforcing steel details and equipment templates for all concrete bases, supports, anchor bolts and other appurtenances necessary for the proper installation of his equipment. Although the Contractor responsible for the work of Division 03 will complete all concrete work, all such work shall be shown in detail on the shop drawings, prepared by HVAC Contractor.

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Comply with requirements in Division 05 "Metal." .

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

C. Refer to Division 23, Section 23 05 29 “Hangers and Supports for HVAC Piping and Equipment for additional requirement

D. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials.

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

F. Field welding: Comply with requirements AWS D1.1 titled “Structural Welding Code.”

3.10 GROUTING

A. Install nonmetallic nonshrink grout for mechanical equipment base bearing surfaces, fans, pump and other equipment base plates.. Mix grout according to manufacturer's printed instructions.

B. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

C. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

D. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

E. Packaging: Premixed and factory packaged.

F. Clean surfaces that will come into contact with grout.

G. Provide forms for placement of grout, as required.

H. Avoid air entrapment when placing grout.

I. Place grout to completely fill equipment bases.

J. Place grout on concrete bases to provide a smooth bearing surface for equipment.

K. Place grout around anchors.

L. Cure placed grout according to manufacturer's printed instructions.

3.11 CATWALKS, PLATFORMS, HANDRAILS AND LADDERS:

A. All catwalks, platforms, handrails and ladders shall be furnished and installed where shown on the drawings, specified or required to give safe access to all equipment needing regular servicing.

B. All catwalks, platforms, handrails and ladders shall comply with OSHA requirements.

C. As part of their work, this contractor shall engage the services of a licensed professional structural engineer with experience in the field of catwalk and platforms. He shall design and coordinate the catwalks, platforms, handrails, ladders and supports. The design shall be performed and certified (signed and sealed) by the licensed engineer.

D. Structural Performance: Design, engineer, fabricate and install the catwalks, platforms, handrails, ladders and supports to withstand the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections.

1. The catwalks and platforms shall be capable of withstanding the following loads applied as indicated:

   a. Uniformly distributed live load of 250 lbs. per sq. ft. and a concentrated load of 8,000 lbs, whichever produces the greater stress. Limit deflection to L/360 or 3", whichever is less.

2. The handrails and ladders shall be capable of withstanding the following loads applied as indicated:

   a. Uniformly distributed live load of 100 lb. per sq. ft. and a concentrated load of 300 lbs on an area of 4 square inches, whichever produces the greater stress. Limit deflection to L/360 or 3", whichever is less.

3. Design of structural steel shall be based upon a unit working tensile stress of 20,000 psi and shall conform to specifications of AISC, ACI, ASTM and OSHA.

4. The catwalks, platforms, handrails, ladders and supports shall be capable withstanding the seismic loads as outlined in another section of this work.

E. All catwalks, platforms, handrails, ladders, supports and structural members shall be galvanized steel.

F. Fabricate cut-outs in grating sections for penetrations of sizes and at locations indicated and as required to accommodate the installation of the work. Cut openings neatly and accurately to size: edge-band openings with bars having a thickness not less than overall grating thickness at contact points.

G. Wherever gratings are pierced by pipes, ducts and/or structural members, cut openings neatly and accurately to size and weld a steel strap collar not less than 1/8" thick to the cut ends.

H. The stringers shall be formed of galvanized steel channels. Floor gratings shall be made of 1 in. x 2 in. galvanized steel bars assembled on edge with a clear space between bars of not more than 3/4 in. The bars shall be welded to stringers. Supplementary steel members shall be attached to building structural members with 2 in. x 2 in. x 1/4 in. clip angles or 1/4 in. steel plates. Suspension angles shall be welded directly to stringers.

I. Catwalks and platforms shall be constructed with galvanized steel stringers supported with structural supports from below and provided with galvanized steel floor grating. Structural supports shall be anchored to floor construction, as required to meet structural loads as detailed above. Any additional structural members required to support the catwalk or platform and to make the connections herein specified shall be furnished and installed by this contractor.

J. The stringers shall be formed of galvanized steel channels. Floor gratings shall be made of 1 in. x 2 in. galvanized steel bars assembled on edge with a clear space between bars of not more than 3/4 in. The bars shall be welded to stringers. Supplementary steel members shall be attached to building structural members with 2 in. x 2 in. x 1/4 in. clip angles or 1/4 in. galvanized steel plates. Suspension angles shall be welded directly to stringers.

K. Railings: Railings shall be provided on both sides of catwalks and platforms (except within 3 in. of a wall) and on both sides of ladders. They shall be constructed with 1-1/2 in. standard weight galvanized steel pipe. Vertical members shall be not more than 8 ft. apart. Steel angles for suspension of catwalks may be vertical members of the railing.

L. The catwalk railing shall consist of two horizontal members. The upper horizontal member shall be 42 in. above walkway floors or the nosing of treads; the other member shall be located at approximately half of this height. Where openings in railings are provided for portable ladder, two slack chains shall be installed across the openings in place of the rails, one end of each to be attached by a hook.

M. Toe Boards: Steel toe boards not less than 4 in. high and at least 3/16 in. thick galvanized steel plate shall be provided on both sides of all catwalks and platforms located 8 ft. or more above the nearest floor and at the edge around openings. Toe boards shall be welded to, and centered between each railing post.

N. Ladders: Galvanized Steel Ladders shall be provided where shown on the drawings and as required to provide full access to all platforms and catwalks. Ladders shall comply with requirements of ANSI A14.3. Ship ladders shall be constructed with galvanized steel plate stringers and floor grating treads.

O. Railings, consisting of two (2) sloping members shall be provided for all ladders. Railings shall be as described above.

P. Stringers shall be set at an angle of 60 with the floor unless otherwise shown and shall be bolted to the channel stringers. Treads shall be of the same construction as walkway floor gratings and shall be attached to stringers with 1-1/4 in. x 1-1/4 in. x 1/4 galvanized in steel angles using 3/8 in. machine bolts.

Q. Vertical ladders shall be constructed using 1-1/2 in. x 3/8 in. galvanized steel side bars spaced 18 in. apart and 5/8 in round steel rungs spaced 12 in. apart. Rungs shall be tapered on ends and securely welded into the side bars.

R. Steel ladder members shall be attached to concrete floors with 2 in. machine bolts and expansion shields of the double clinch type.

S. Provide ladder safety cages.

T. All metal parts of catwalks, platforms and ladders shall be given a shop coat of red and linseed oil paint. All steel work shall be given a final coat of Rustoleum enamel.

U. Project Conditions: Check actual locations of walls and other construction to which catwalks, platforms and ladders must fit, by accurate field measurements before fabrication. Show recorded measurements on final shop drawings.

W. Submittals:

1. Plans, elevations, sections and details of metal fabrications and their connections.

2. In addition to the coordination requirements specified elsewhere in the contract documents, it shall be the responsibility of this contractor to confirm all dimensions and structural details based on the latest architectural and structural drawings relating to column, beam or wall locations or any other obstructions that must be accommodated as part of the catwalks, platforms and ladders or to provide proper clearances.

3. Certification that the catwalks, platforms, handrails and ladders have been designed, engineered and fabricated to meet the structural performance requirements (design loads) as specified herein. Certification shall be signed and sealed by the qualified professional engineer responsible for their preparation whose services are engaged by the manufacturer and/or fabricator.

END OF SECTION 23 05 29

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SECTION 23 05 47 - VIBRATION CONTROLS FOR MECHANICAL/ELECTRICAL SYSTEMS (NON-SEISMIC)

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section includes requirements for the vibration isolation controls for this Division's equipment and systems and installation within, on or outside the Building as herein specified.

B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

C. Description of Work:

1. Provide a complete system of vibration isolation for systems and equipment as specified herein, and as needed for a complete and proper installation.

2. Provide vibration isolation systems for every System as shown and specified per Contract Documents.

3. The work of this section includes, but is not limited to, the following:

a. Vibration isolation elements for ductwork (if required), conduit, piping, equipment, systems, etc. as herein specified

b. Equipment isolation bases as herein specified

c. Piping flexible connections

D. This specification is part of the HVAC contracts.

E. It shall be understood that the requirements of this section are for the support, fastening, and isolating of equipment, components, ductwork, piping and conduit work. Nothing on the drawings or specifications shall be interpreted as a reason to waive the requirements of this wind load design section.

F. All outdoor equipment, including grade and roof mounted components shall comply with applicable code and section covering "wind loading". There shall be no decrease of the effects of wind load on a component due to other structures or components acting as blocks or screens.

G. Wind load and isolation materials shall be the certified products of the same manufacturing group and shall be certified by that group.

H. It is the intent of this Section of the Specification to keep all outdoor (roof and/or grade) HVAC, Plumbing, Fire Protection and Electrical Building System components in place and operational during a high wind event for buildings designated as "Essential Facilities" or sections of the building designated as an "Essential Facility". For all other buildings, it is the intent of this Section of the Specification to keep all outdoor (roof and/or grade) HVAC, Plumbing, Fire Protection and Electrical "Life Safety and or High Hazard" Building System components in place and operational during a high wind event.

I. All such systems must be installed in strict accordance with wind codes, component manufacturer's and building construction standards. Whenever a conflict occurs between the manufacturers or construction standards, the most stringent installation practice shall apply.

J. This specification is considered to be minimum requirements for wind control consideration. Whenever a conflict occurs between the specifications and the code or within the specification or drawings themselves, the most stringent practice shall apply.

K. Any variation which results in non-compliance with the specification requirements shall be corrected by the contractor in an approved manner, at no additional cost.

L. The work in this section includes, but is not limited to, the following:

1. Wind design requirements for outdoor equipment (components).

2. Certification of wind restraint designs and installation supervision.

3. Certification of attachment of housekeeping pads.

4. All equipment (components) requiring code compliance.

5. All inspection and test procedures for equipment (components) requiring code compliance.

6. All heating, ventilating and air conditioning systems within or outside of building that require vibration isolation and restraint, vibration isolation (only) and restraint (only). Equipment buried underground is included if essential to the building's functioning in the event of a wind event. Entry services to the building, up to but not including Utility connections, is part of this specification. Equipment listed below is typical. It is the intent of this specification section that all equipment that requires vibration isolation and restraint, vibration isolation (only) and restraint (only) is included as part of this specification. All systems that are part of the building in any way are referred to as components including but not limited to:

7. All heating, ventilating and air conditioning systems within or outside of building that require vibration isolation. It is the intent of this specification section that all equipment that requires vibration isolation is included as part of this specification. All systems that are part of the building in any way are referred to as components including but not limited to:

    a. AC Units

    b. Air Handling Units

c. Compressors

d. Ductwork (where required in Part 3)

e. Equipment Supports

f. Fans (all types)

g. Fire Alarm Panels

h. Generators

i. Pipe

j. Pumps (all types)

k. Risers

l. Rooftop Units

m. Transformers

n. Vibration Isolators

M. This project requires compliance with Wind requirements for equipment located outdoors (roof and/or grade) in:

1. American Society of Civil Engineers (ASCE 7-05)

2. Applicable State and Local Codes having jurisdiction

N. Contractor responsible for the work of this Division shall engage the services on an independent Licensed Professional Engineer in the State of New York, with a minimum of 10 years' experience in the field of equipment supports and wind restraint

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. In the event that this section conflicts with the isolation or seismic requirements of other sections, the more stringent criteria stated herein shall apply.

B. This Section is a part of each Section of this Division.

C. This Section is applicable to all systems, equipment, etc. shown on the Fire Protection Plumbing HVAC Electrical Contract Drawing associated with the work of this Division.

1.3 APPLICABLE PUBLICATIONS CODES AND STANDARDS

A. City, State and Local Codes (Code) (Having Jurisdiction)*

B. BOCA National Building Code/1996 (Code)

C. International Building Code

D. International Mechanical Code

E. International Plumbing Code

F. NFPA 70 - National Electric Code

G. American Society of Civil Engineers (ASCE 7-05)*

H. New York State Building Code

I. International Energy Conservation Code

J. NFPA 13 and 14 for Fire Protection System (Standard)*

K. American Society For Testing and Materials (ASTM) (Standard)*

L. International Conference of Building Officials (ICBO) (Standard)

M. American National Standard Institute (ANSI):*

N. Air Moving and Conditioning Association (AMCA):*

O. American Society of Mechanical Engineers (ASME):*

P. National Fire Protection Association (NFPA):*

Q. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).*

R. Occupational Safety and Health Administration (OSHA).*

S. Underwriters Laboratories (UL).*

1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and as specified in Division 01 Section "SUBMITTALS."

B. Prior to purchasing any equipment or materials, a list of their manufacturers shall be submitted for review.

C. The manufacturer of vibration isolation and wind restraints shall provide submittals for products and materials as follows:

1. Descriptive Data:

a. Catalog cuts and data sheets on specific vibration isolators to be utilized showing compliance with the specifications.

b. An itemized list showing the items of equipment or piping to be isolated, the isolator type and model number selected, isolator loading and deflection and base and construction where applicable.

D. Shop Drawings:

1. Drawings showing equipment base constructions including dimensions, structural member sizes and support point locations.

2. Drawings showing details of suspension and support for ceiling hung equipment.

3. Drawings showing methods for isolation of pipes and ductwork piercing walls and slabs.

4. Concrete and steel details for bases, including anchor bolt locations.

E. Documents will not be accepted for review unless:

1. They include complete information pertaining to appurtenances and accessories.

2. They are submitted as a package where they pertain to related items.

3. They are properly marked with service or function, project name, where they consist of catalog sheets displaying other items which are not applicable.

4. They indicate the project name and address along with the Contractor's name, address and phone number.

5. They are properly marked with external connection identification as related to the project where they consist of standard factory assembly or field installation drawings.

6. All documents relating to wind restraint shall be stamped, sealed and signed by Licensed Professional Engineer whose service were engaged by the Contractor responsible for the work of this Division.

1.5 QUALITY ASSURANCE

A. All vibration isolation and restraint devices (if required for wind consideration) shall be the product of a single manufacturer.

B. The following manufacturers will be reviewed for approval, provided their systems strictly comply with the design intent for performance, deflection and structural capacity of this specification.

1.	Vibration Mountings & Controls (VMCI)	Bloomingdale, NJ
2.	Korfund Dynamics Corp. (KDC)	Bloomingdale, NJ
3.	Amber Booth (AB)	Houston, TX
4.	Mason Industries Inc. (MII)	Hauppauge, NY
5.	Vibration Eliminator Co. Inc. (VECI)	Long Island City, NY
6.	Kinetics Noise Control (KNC)	Dublin, OH

C. Vibration isolation firms having a minimum of ten (10) years experience in designing and installing vibration isolation systems shall be qualified to provide the materials and installation required by this section. Project listings shall be provided including geographical location and a reference contact.

D. The installation of all vibration isolation units and hangers and bases, shall be under the direct supervision of the vibration isolation manufacturers' representative.

E. Manufacturer of vibration isolation and wind load (if required) control equipment shall have the following responsibilities:

1. Determine vibration isolation sizes and locations.

2. Provide vibration isolation as scheduled or specified.

3. Provide restraint systems for equipment and components subject to high wind per recommendation from Licensed Professional Engineer engaged by the Contractor responsible for the work of this Division.

4. Provide installation instructions and drawings to ensure proper installation and performance.

5. All provisions of Section titled, General Design & Performance Requirements.

F. Equipment manufacturers' substitution of internally or externally isolated equipment supplied by the equipment vendor, in lieu of the isolation specified in this Section, is acceptable provided all conditions of this Section are met.

1.6 All costs for converting to the specified vibration isolation shall be borne by the equipment vendor in the event of non-compliance with the preceding. DEFINITIONS

A. Essential Facilities (Subject to high winds)

1. Buildings and other structures that are intended to remain operational in the event of extreme environmental loading from wind.

a. All HVAC, Plumbing, Fire Protection & Electrical Systems/Components (subject to high winds) in a building designated as an “Essential Facility” shall be restrained to remain in place and operational. The Systems/ Components shall include but not be limited to:

(i) ADD LIST OF SYSTEM/COMPONENTS

b. For project where a limited area of the building has been designated an "Essential Facility", all HVAC, Plumbing, Fire Protection & Electrical System/Components serving the designated "Essential Facility" area (subject to high wind) shall be restrained to remain in place and operational including but not limited to:

(i) ADD LIST OF SYSTEM/COMPONENTS

B. Life Safety and High Hazard (Subject to high winds)

1. All systems (Life Safety) involved with the Fire Protection System of the building subject to high winds shall remain in place and operational including but not limited to:

a. ADD LIST OF SYSTEM/COMPONENTS

2. All systems (Life Safety and High Hazard) involved with the Plumbing System of the building subject to high winds shall remain in place and operational including but not limited to:

a. ADD LIST OF SYSTEM/COMPONENTS

3. All systems (Life Safety and High Hazard) involved with the Heating, Ventilating and Air Conditioning System of the building subject to high winds shall remain in place and operational including but not limited to:

a. ADD LIST OF SYSTEM/COMPONENTS

4. All systems (Life Safety and High Hazard) involved with the Electrical System of the building subject to high winds shall remain in place and operational including but not limited to:

a. ADD LIST OF SYSTEM/COMPONENTS

C. Other Mechanical/Electrical Systems (Subject to high wind)

1. Mechanical/Electrical Systems involved with the building subject to high wind shall remain in place

a. ADD LIST OF SYSTEM/COMPONENTS

D. Basic Wind Speed: The basic wind speed, in Miles per Hour (MHP), for determination of the wind loads, shall be per criteria in (ASCE7-16) or local code (if more severe). For projects located in special wind regions near gorges or mountain terrain, Local authorities having jurisdiction shall determine wind speeds. Wind load design shall be determined based on the procedure outlined in American Society of Civil Engineers ASCE-7-05 Section 6.5.4. In no event shall the wind speed for the wind load design be less 100 MPH.

E. Component: A non-structural part or element of an architectural, electrical, heating, ventilating and air conditioning (HVAC), plumbing or fire protection system within or without of a building system.

F. System or System/Component: Compete installation consisting of equipment, ductwork, piping, conduit, electrical raceways, etc. also called component or equipment described above.

G. Hurricane Prone Regions: Areas prone to hurricanes include the U.S. Atlantic Ocean, Gulf Coasts, Hawaii, Puerto Rico, Guam, Virgin Islands, and American Samoa where the wind speed is greater than 90 mph.

H. Wind-Borne Debris Region: Portions of hurricane-prone regions that are within 1 mile of the coastal mean high water line where the basic wind speed is 110 mph or greater, the wind speed for the site is 115 MPH per ASCE7-16.

1.7 GENERAL DESIGN AND PERFORMANCE REQUIREMENTS

A. General Design Requirements.

1. WIND CONSIDERATIONS: This project has wind design requirements as follows:

a. Wind load in hurricane and or wind-born debris regions have a building height less than 60 Feet.

B. General Design Performance Requirements

1. Wind Load Certification and Analysis

a. Calculations by a Licensed Professional Engineer (engaged by the Contractor responsible for the work of this Division) registered in the State the Project is located in substantiating the mounting system for wind restraint and recommended anchor bolts shall be submitted for review along with the shop drawings. Calculations for wind loads shall be based on winds load as specified herein. All analysis shall be stamped by the above referenced Licensed Professional Engineer.

b. Unless otherwise specified System/Components shall be restrained to resist wind force. Restraints shall maintain System/Components in a captive position. Restraint devices shall be designed to meet wind requirements as defined in Applicable Code or by local authorities having jurisdiction.

2. Design Wind Loads:

a. All outdoor mounted components shall be positively fastened to their supporting structure.

b. If equipment is dunnage mounted, positive attachment shall occur through welding or bolting of equipment to dunnage steel.

c. Loads and calculations shall be based on Applicable Code and/or local authorities having jurisdiction and related sections in American Society of Civil Engineers ASCE-7-05.

d. Where buildings are less than 60 feet in height, loads for roof mounted System/Components shall be based on American Society of Civil Engineers ASCE-7-05 Section 6.15.1.

e. Equivalent basic wind speed shall be based on Applicable Code and/or local authorities having jurisdiction.

f. In no event shall the basic wind speed for wind load design be less than 100 MPH.

g. In no event shall adjacent buildings, structures or screens be considered to diminish the calculated wind load or its effect on an outdoor component.

1.8 CONTRACTOR RESPONSIBILITIES AND APPROVALS

A. The Contractor responsible for the work of this Division shall provide (furnish and install) all vibration isolation systems for the equipment, ductwork, piping electrical raceways, bus duct, cable trays, etc. and if project requires wind considerations, shall provide (furnish and install) restraint systems in addition to vibration isolation systems.

B. The Contractor responsible for the work of this Division shall engaged the services of a Licensed Professional Engineer registered in the State the project is located to:

1. Analyze, calculate, select restraint system for systems/components listed in previous paragraph titled "Definitions" of this section, review and approve shop drawing and provide Site visit to review installation of restraint systems and provide inspection report.

1.9 MANUFACTURER RESPONSIBILITIES

A. The manufacturer of vibration isolation, wind restraint equipment shall, as part his work, engage the services of a Licensed Professional Engineer (registered in the State that the Project is located in), who shall have the following responsibilities:

1. Design the vibration isolation sizes and locations.

2. Provide ductwork (if required), piping and equipment isolation systems as to meet the requirements as specified herein.

3. Guarantee specified isolation system deflection.

4. Provide installation instructions, drawings and field supervision to assure proper installation and performance.

5. Provide restraint equipment where project requires wind consideration to meet forces determined by the Licensed Professional Engineer engaged by the Contractor responsible for the work of this Division.

1.10 MISCELLANEOUS

A. Housekeeping pads shall be sized to have a minimum of 6 inches (15 cm) of clearance all around the equipment or 12 bolt diameters, whichever is greater.

B. All components shall be positively attached to the building structure and be approved by the structural engineer. Positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double-sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure.

PART 2 - PRODUCTS

2.1 GENERAL

A. All vibration isolation and restraint systems (if project requires wind considerations) shall be the product of a single manufacturer. The manufacturer model numbers for the specified vibration isolation systems, restraint systems (if project requires wind considerations) and equipment bases is based on Vibration Mounting and Controls (VMC) and are the standard for acceptance. Vibration isolations systems, restraint systems (if project requires wind considerations) and equipment bases manufactured by the Manufacturers listed in Part 1 of this Section will be acceptable provided they fully comply with the requirements of the standard.

2.2 INSPECTION

A. On completion of installation of all vibration isolation and either or both wind restraint devices herein specified, the local representative of the isolation materials manufacturer shall inspect the completed system and report in writing any installation errors, improperly selected isolation or restraint devices, or other faults that could affect the performance of the system. Contractor shall submit a report to the Architect, including the manufacturer's representative's final report, indicating all isolation devises reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

1. Licensed Professional Engineer, engaged by the Contractor responsible for the work of this Division, shall inspect the completed installation and report in writing any installation errors improperly selected restraint devices or other faults that could affect the performance on the restraint system. Contractor shall submit a report to the Architect, including the Licensed Professional Engineer’s final report, indicating all restraint devices reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the restraint device work.

2.3 VIBRATION ISOLATION TYPES

A. Note that vibration isolation devices are included herein for coordination purposes only. Vibration isolation is specified under another section of this work.

B. Type A: Spring Isolator – Free Standing

1. Manufacturer: Vibration Mounting and Controls

a. Model AB

2. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded elastomeric cup or ¼" elastomeric acoustical friction pad between the bottom of isolator and the support.

3. All mountings shall have leveling bolts that must be rigidly bolted to the equipment.

4. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load.

5. Springs shall have a minimum additional travel to solid equal to 50% of the operating deflection.

6. Springs shall have a ratio of horizontal stiffness to vertical stiffness of between 0.8 and 1.25.

7. Each spring isolator shall be designed and installed so that the ends of the spring remain parallel during and after the spring installation

8. Spring shall be laterally stable without housing, snubbers or guides.

9. Mounting shall include two hole rectangular steel baseplate with two holes for bolting to structure.

10. Springs shall be color-coded for identification of rated load capacity.

11. All isolators shall operate in the linear portion of their load versus deflection curve and have 50% excess capacity without becoming coil bound.

12. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height.

C. Type B: Restrained Spring Isolator VMC:

1. Manufacturer: Vibration Mounting and Controls

   a. Model MS

2. Housed spring mounting shall have characteristics as specified for Type "A" spring isolator

3. Housing shall be cast ductile iron, malleable cast iron or welded steel construction. Gray cast iron not permitted

4. Housing shall include vertical limit stops to prevent spring extension during weight changes or when equipment is exposed to uplift loads such as wind loads. Limit stops shall be out of contact during normal operation

5. Housing shall serve as blocking during erection.

6. Housing design shall provide a minimum of ¼ inch between restraining bolt and housing and spring to prevent interference with spring performance.

7. Housing shall have an adjusting bolt on top of spring compressing plate

8. Neoprene acoustical non-skid pad (minimum ¼ inch thick) shall be attached to bottom of base plate.

9. Housing shall include provisions to adjust the rebound plate and inspect the spring.

10. Base plate shall be rectangular and have bolts holes to allow for isolator to be bolted or welded to structure.

11. For projects with wind considerations, housing shall be designed to resist all wind forces.

D. Type C: Combination Spring/Elastomer Hanger Isolator (30° Arc Type)

1. Manufacturer: Vibration Mounting and Controls

a. Model: HRSA

2. Hanger Isolator shall be a 1 ¼ inch thick elastomeric element at top of hanger housing with resilient bushing projecting through housing in series with a steel spring.

3. Isolator housing shall be steel box design

4. Spring shall have characteristics as specified for Type "A" spring isolator and shall be seated in a steel washer reinforced elastomeric cup at bottom.

5. Elastomeric element and elastomeric cup shall have elastomeric bushing projecting through steel box

6. Spring diameter and hanger box lower hole design shall be large enough to permit hanger rod to swing through a 30° arc from side to side before contacting the rod bushing and short circuiting spring.

7. Isolator to be used to hanger ductwork utilizing flat iron duct straps shall include eye bolts at both ends.

8. Submittals shall include hanger drawing showing the 30° capability.

E. Type C-1 Combination Spring/Elastomer Hanger Isolator (30° Arc Type) (Pre-Positioning)

1. Manufacturer: Vibration Mounting and Controls

a. Model: HRSPA

2. Hanger isolator shall have characteristics as specified for Type "C" Hanger isolator except:

a. Hanger isolators design shall include a means of holding equipment, piping, etc. at fixed elevation during installation regardless of load changes and a means of transferring load to spring.

F. Type C-2 Combination Spring/Elastomer Hanger Isolator (30° Arc Type) (Pre-compressed)

1. Manufacturer: Vibration Mounting and Controls

a. Model: HRSA-PR

2. Hanger isolator shall have characteristics as specified for Type "C" Hanger isolator except:

   a. Hanger isolator spring shall be pre-compressed to specified deflection to support equipment, piping, etc. at fixed elevation during installation regardless of load changes.

   b. Hanger design shall include a release mechanism to free spring after installation is complete and the hanger is subjected to full load.

G. Type D: Elastomer Double Deflection Hanger Isolator

1. Manufacturer: Vibration Mounting and Controls

   a. Model: HR

2. Molded (minimum 1 ¼" thick) DuruleneTM element with projecting bushing lining the rod clearance hole. Static deflection at rated load shall be a minimum of 0.35".

3. Steel retainer box encasing elastomeric mounting capable of supporting equipment up to four times the rated capacity of the element.

H. Type E Combination Spring/Elastomer Hanger Isolator

1. Manufacturer: Vibration Mounting and Controls

   a. Model: HRS

2. Hanger isolator shall have characteristics as specified for Type "C" Hanger isolator except:

   a. 30° angularity not required for Hanger isolators

I. Type E-1 Combination Spring/Elastomer Hanger Isolator (Pre-positioning)

1. Manufacturer: Vibration Mounting and Controls

   a. Model: HRSP (pre-positioning)

2. Hanger isolator shall have characteristics as specified for Type "C" Hanger isolator except:

   a. 30° angularity not required for Hanger isolators

   b. Hanger isolator spring shall incorporate a means for supporting equipment, piping, etc. at fixed elevation during installation regardless of load changes and a means of transferring load to spring

J. Type E-2 Combination Spring/Elastomer Hanger Isolator (Pre-compressed)

1. Manufacturer: Vibration Mounting and Controls

   a. Model: HRS-PR (pre-compressed)

2. Hanger isolator shall have characteristics as specified for Type "C" Hanger isolator except:

   a. 30° angularity not required for Hanger isolators

   b. Hanger isolator spring shall be pre-compressed to specified deflection to support equipment, piping, etc. at fixed elevation during installation regardless of load changes.

   c. Hanger design shall include a release mechanism to free spring after installation is complete and the hanger is subjected to full load

K. Type F: Not used for Non-Seismic Projects

L. Type G: Pad Type Elastomer Isolator (Standard)

1. Manufacturer: Mason Industries

   a. Type L Maxiflex

2. One layer of 18" x 18" x ¾" thick elastomeric pad consisting of 2" square modules; "E-Z" cut for size required.

3. Load distribution plates shall be used as required.

4. Bolting required for seismic compliance. Elastomeric and duck washers and bushings shall be provided to prevent short-circuiting.

M. Type H: Pad Type Elastomer Isolator (High Density)

1. Manufacturer: Vibration Mounting and Controls

   a. Model: Fabriflex

2. Laminated multiple layers canvas duck & neoprene, maximum loading 1000 psi, minimum 2" thick.

3. Load distribution plate shall be used as required.

4. Bolting required for seismic compliance. Elastomeric and duck washers and bushings shall be provided to prevent short circuiting.

N. Type I: Thrust Restraints

1. Manufacturer: Vibration Mounting and Controls

   a. Model: TRK

2. Construction shall consist of a spring in series with a neoprene pad or cup, threaded rods, washers, nuts, back-up plates and steel angles.

3. Thrust restraint design shall allow for field conversion from compression to tension.

4. Spring shall have characteristics as specified for Type "A" spring isolator

5. Design of thrust restraint shall limit air handling equipment movement to ¼ inch and shall be installed in pairs.

6. Thrust restraints shall be installed on air handling equipment whose thrust exceeds 10% of air handling equipment weight.

O. Type J: Pipe Anchors

1. Manufacturer: Vibration Mounting and Controls

   a. Model: AG

2. Multi-directional pipe anchor consisting of steel sections in series with heavy duty duck and neoprene material assembled in a telescopic housing

3. Design of anchor suitable for restraint in both the horizontal and vertical direction and balanced in all directions.

4. Loads on material shall not exceed 500 PSI.

P. Type K: Pipe Guides

1. Manufacturer: Vibration Mounting and Controls

   a. Model: LD

2. Provide resilient pipe guide for vertical pipe riser between anchor supports.

3. Construction of pipe guide shall consist of a four side angle iron frame with double deflection neoprene mountings. Neoprene mounting will be connected to each side of the frame aligning with center-line of pipe riser.

4. Neoprene mounting shall be color-code for identify rated load capacity.

5. Clearance between pipe/pipe insulation as required for pipe movement but not less than ½ inch.

6. In lieu of pipe described above, a vertical sliding pipe guide design maybe provided

   a. Manufacturer: Mason Industries; model VSG

   b. Guide design two steel tubes (one inside the other) with a minimum ½ inch thick, 60-durometer elastomer in the space between the two tubes.

   c. Height of guide shall be factor preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and re-insertable to allow for selection of pipe movement.

d. Pipe guide vertical movement as required to meet project requirements or a minimum of ± 1 5/8 inches.

Q. Type L: Isolated Pipe Hanger System

1. Manufacturer: Vibration Mounting and Control

a. Model: CIH, CIR, TIH, PIH

2. Spring-flex hanger system consisting of consisting of a pre-compressed spring and elastomer isolation hanger combined with pipe support into a single assembly.

3. System shall consist of spring element with a lower steel spring retainer and an upper elastomer retainer cup with integral bushing to insulate the support rod from the isolator hanger.

4. Spring shall have characteristics as specified for Type "A" spring isolator

5. Elastomeric element with integral bushing located under steel spring retainer. Bushing design to insulate support rod from steel spring retainer.

6. Hanger shall hinged to allow for up to 30° misalignment between rod attachment to structure and isolation hanger.

7. Hanger shall be designed and constructed to support loads over three times the rated load without failure.

8. Systems shall be pre-compressed to allow for rod insertion and standard leveling.

9. Hanger system shall be suitable to replace standard clevis, single or double rod roller or double rod fixed support.

2.4 WIND RESTRAINT SYSTEMS

A. Licensed Professional Engineer (engaged by the Contractor responsible for the work of this Division) shall design, specify, review and approve shop drawings, inspect final installation and submit final report certifying that the installation conforms to requirements for either or both Wind restraint systems.

1. Licensed Professional Engineer shall review, make recommendations for modifications (if require) to equipment bases specified in a subsequent paragraph in Part 2 to meet either or both wind forces and anchorage requirements.

2.5 EQUIPMENT BASES

A. General

1. All curbs and roof rails are to be bolted or welded to the building steel or anchored to the concrete deck (minimum thickness shall be 4") for resisting wind load forces in accordance with the project location. (Fastening to metal deck is unacceptable).

2. All curbs and roof rails are to be bolted or welded to the building steel or anchored to the concrete deck (minimum thickness shall be 4"). (Fastening to metal deck is unacceptable).

B. Base Types

1. Type B-1: Integral Structural Steel Base

a. Manufacturer: Vibration Mounting and Controls

(i) Model: WFB

b. Rectangular bases are preferred for all equipment.

c. Where required to suit equipment, rectangular structural steel bases shall include built-in adjustable motor slide rails.

d. All perimeter members shall be structural steel beams with a minimum depth equal to 1/12 of the longest dimension of the base.

e. Base depth need not exceed 12" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.

f. Height saving brackets shall be employed in all mounting locations to provide a minimum base clearance of 2".

2. Type B-2: Concrete Inertia Base

a. Manufacturer: Vibration Mounting and Controls

(i) Model: MPF/WPF

b. Vibration isolation manufacturer shall furnish rectangular or “T” shaped welded or bolted modular steel concrete pouring forms for floating and inertia foundations.

c. Bases shall have a minimum depth of 1/12 of the longest dimension of the base but not less than 6".

d. The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity.

e. Forms shall include a minimum concrete reinforcing consisting of ½" bars welded in place a maximum of 12" on centers running both ways in a layer 1 ½" above the bottom.

f. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured.

g. Height saving brackets shall be employed in all mounting locations to maintain a 2" minimum clearance below the base.

3. Type B-3: Restrained Spring Isolation Curb

   a. Manufacturer: Vibration Mounting and Controls

      (i) Model: P6100/P6200/P6300; Model per scheduled deflection requirements in Part 3

   b. Roof curb shall be custom designed to suit the approved roof-top unit. HVAC Contractor to provide details of the approved roof-top unit to manufacturer of the roof curbs and submit the shop drawings of the roof curb to the roof-top unit manufacturer for approval.

   c. Roof curb shall generally consist of but not be limited to:

      (i) An upper floating structural frame designed for continuous support of unit and captive to resiliently resist wind forces for the location of the project. Wind hold down to connect roof-top unit to upper structural rail.

      (ii) Top flashing to provide weather-tight installation

      (iii) Wood nailer strip

      (iv) Spring isolators shall have characteristics as specified for Type "A" spring isolator, be laterally stable, rest on ¼ inch thick elastomeric and be color coded for proper identification. Spring shall be mounted in an accessible waterproof spring pockets to allow for spring removable, replacement and curb/equipment level adjustment. Where required to accommodate an extended height curb, spring isolators shall be mounted on a spring stanchion designed to resist wind forces for the location of the project.

      (v) Spring pockets shall contain combination horizontal and vertical restraints in conjunction with ¼ inch thick neoprene rubber bushing designed to resist wind forces at location of project.

      (vi) Lower continuous structural rail designed to accept point spring loads transferred from the roof-top unit to the building structure. Lower structural rail shall include provisions to connect roof curb to building structure capable of resisting wind forces at project location.

      (vii) Design of equipment load transfer to building structure shall be through roof curb contact point only.

      (viii) Perimeter walls of curb shall be provided with an insulation support shield (expanded metal) suitable installation of 2 inches of roofing type board insulation.

(ix) Perimeter and duct connection of the upper structural frame shall include a continuous neoprene elastomeric air seal to prevent air infiltration or exfiltration. Design of air seal shall be such that air seal is not subject to failure or in the event of failure water will not leak into the curb.

(x) Provide reinforcing cross-bracing as required to support unit and resist wind forces.

(xi) Upper structural rail shall include duct supports to match unit supply and return duct connections and suitable for flexible connection of supply and return ductwork.

(xii) Hardware shall be plated and springs shall be powder coated or cadmium plated.

(xiii) Curb waterproofing shall be designed to meet all requirements of National Roofing Contractor Association (NRCA)

d. Height of roof curb shall be

(i) Minimum as required by Manufacturer to construct curb assembly

(ii) As specified on drawings.

(iii) As required to accommodate horizontal duct offset above roof of supply and return ductwork with the bottom of horizontal duct 6 inches above roof.

(iv) Curb Manufacturer to coordinate final height requirements with HVAC Contractor

4. Type B-3A: Restrained Spring Isolation Curb with Sound Package

a. Manufacturer: Vibration Mounting and Control

b. Model: P6100/P6200/P6300 with PFMA sound package

c. Application: Supply and Return ductwork shall make a flexible connection to sound isolation floor. Sound isolation floor to have supply and return duct openings with angle iron frame to matched to unit supply and return air openings. Provide air-tight connections between sound isolation floor openings and respective opening on unit.

d. Spring isolation curb shall be as describe for Type B-3 above except as follows:

(i) Upper structural rail shall include an angle iron frame welded to the upper rail capable of supporting a continuous sound isolation floor.

(ii) Sound isolation floor shall be a "double-walled" panel consisting of a heavy gauge galvanized (G-90) sheet metal capable of spanning width of unit with 4 inches acoustical liner. Panel shall be capable of supporting 20 psf not weighting more than 6psf. Sound isolation floor design shall provide an air-tight joint between panels.

(iii) Sound isolation floor shall be two (2) layers of 5/8 inch sheetrock. Sheetrock joints between layers shall be staggered and provided with a continuous seal of acoustical caulking.

5. Type B-3B: Restrained Spring Isolation Curb with Sound package

a. Manufacturer: Vibration Mounting and Control

b. Model: P6100/P6200/P6300 with RPFMA sound package

c. Application: Supply ductwork shall make a flexible connection to sound isolation floor. A frame return air opening shall be provided in the sound isolation floor and the area between sound isolation floor and roof shall be used as a return air plenum. Sound isolation floor to have supply and return duct openings with angle iron frame to matched to unit supply and return air openings. Provide air-tight connections between sound isolation floor openings and the respective opening on unit.

d. Spring isolation curb shall be as describe for Type B-3 above except as follows:

(i) Upper structural rail shall include an angle iron frame welded to the upper rail capable of supporting a continuous sound isolation floor.

(ii) Sound isolation floor shall be a "double-walled" panel consisting of a heavy gauge galvanized (G-90) sheet metal capable of spanning width of unit with 4 inches acoustical liner. Panel shall be capable of supporting 20 psf not weighting more than 6psf. Sound isolation floor design shall provide an air-tight joint between panels.

(iii) Sound isolation floor shall be two (2) layers of 5/8 inch sheetrock. Sheetrock joints between layers shall be staggered and provided with a continuous seal of acoustical caulking.

(iv) In lieu of expanded metal perimeter walls, curb shall be provided with Galvanized (G90) sheet metal double-walled panels with 2 inches of insulation with a minimum "R" value equal to 12.

(v) Provide a flexible membrane within the perimeter of the curb to provide air tight plenum seal.

e. Height of roof curb shall be adjusted so that the maximum velocity of the return air traveling through the cross sectional area between sound Isolation floor and roof is equal to or less than return air ductwork or as required in Type B-3 for horizontal duct off-sets above roof.

6. Type B-3C: Restrained Spring Isolation Curb with Sound package

   a. Manufacturer: Vibration Mounting and Control

   b. Model: P6100/P6200/P6300 with SRPFMA sound package

   c. Application: Frame supply and return air openings shall be provided in the sound isolation floor and the area between sound isolation floor and roof. Sound isolation floor to have supply and return duct openings with angle iron frame to matched to unit supply and return air openings. Provide air-tight connections between sound isolation floor openings and the respective opening on unit.

   d. Spring isolation curb shall be as describe for Type B-3 above except as follows:

      (i) Upper structural rail shall include an angle iron frame welded to the upper rail capable of supporting a continuous sound isolation floor.

      (ii) Sound isolation floor shall be a "double-walled" panel consisting of a heavy gauge galvanized (G-90) sheet metal capable of spanning width of unit with 4 inches acoustical liner. Panel shall be capable of supporting 20 psf not weighting more than 6psf. Sound isolation floor design shall provide an air-tight joint between panels.

      (iii) Sound isolation floor shall be two (2) layers of 5/8 inch sheetrock. Sheetrock joints between layers shall be staggered and provided with a continuous seal of acoustical caulking.

      (iv) In lieu of expanded metal perimeter walls, curb shall be provided with Galvanized (G90) sheet metal double-walled panels with 2 inches of insulation with a minimum "R" value equal to 12.

      (v) Provide a flexible membrane within perimeter of curb to provide air tight plenum seal and on both sides of plenum divider

      (vi) Provide an insulated plenum divider (full width of curb) to divide the area between sound isolation floor and roof into a supply plenum and return plenum. Construction of plenum divider same as perimeter wall for curb.

   e. Height of roof curb shall be adjusted so that the maximum velocity of the return air traveling through the cross sectional area between sound isolation floor and roof is equal to or less than return air ductwork or as required in Type B-3 for horizontal duct off-sets above roof.

7. Type B-4: Restrained Non-Isolated Curb

   a. Manufacturer: Vibration Mounting and Control

      (i) Model: P6000

   b. Non-isolated curb shall be as described for Type B-3 above except as follows:

(i) Upper structural rail shall not "float" but shall be unitized with the lower structural rail

(ii) Spring isolation not required

(iii) Curb shall be designed to meet the wind force required for the project location

8. Type B-4A: Restrained Non-Isolated Curb with Sound Package

a. Manufacturer: Vibration Mounting and Control

b. Model: P6000 with PFMA sound package

c. Application: Supply and Return ductwork shall make a flexible connection to sound isolation floor. Sound isolation floor to have supply and return duct openings with angle iron frame to matched to unit supply and return air openings. Provide air-tight connections between sound isolation floor openings and respective opening on unit.

d. Non-isolation curb shall be as describe for Type B-4 above except as follows:

(i) Upper structural rail shall include an angle iron frame welded to the upper rail capable of supporting a continuous sound isolation floor.

(ii) Sound isolation floor shall be a "double-walled" panel consisting of a heavy gauge galvanized (G-90) sheet metal capable of spanning width of unit with 4 inches acoustical liner. Panel shall be capable of supporting 20 psf not weighting more than 6psf. Sound isolation floor design shall provide an air-tight joint between panels.

(iii) Sound isolation floor shall be two (2) layers of 5/8 inch sheetrock. Sheetrock joints between layers shall be staggered and provided with a continuous seal of acoustical caulking.

9. Type B-4B: Restrained Non-Isolated Curb with Sound Package

a. Manufacturer: Vibration Mounting and Control

b. Model: P6000 with RPFMA sound package

c. Application: Supply ductwork shall make a flexible connection to sound isolation floor. A frame return air opening shall be provided in the sound isolation floor and the area between sound isolation floor and roof shall be used as a return air plenum. Sound isolation floor to have supply and return duct openings with angle iron frame to matched to unit supply and return air openings. Provide air-tight connections between sound isolation floor openings and the respective opening on unit.

d. Non-isolation curb shall be as describe for Type B-4 above except as follows:

(i) Upper structural rail shall include an angle iron frame welded to the upper rail capable of supporting a continuous sound isolation floor.

(ii) Sound isolation floor shall be a "double-walled" panel consisting of a heavy gauge galvanized (G-90) sheet metal capable of spanning width of unit with 4 inches acoustical liner. Panel shall be capable of supporting 20 psf not weighting more than 6psf. Sound isolation floor design shall provide an air-tight joint between panels.

(iii) Sound isolation floor shall be two (2) layers of 5/8 inch sheetrock. Sheetrock joints between layers shall be staggered and provided with a continuous seal of acoustical caulking.

(iv) In lieu of expanded metal perimeter walls, curb shall be provided with Galvanized (G90) sheet metal double-walled panels with 2 inches of insulation with a minimum "R" value equal to 12.

(v) Provide a flexible membrane within perimeter of the curb to provide air tight plenum seal.

e. Height of roof curb shall be adjusted so that the maximum velocity of the return air traveling through the cross sectional area between sound isolation floor and roof is equal to or less than return air ductwork or as required in Type B-3 for horizontal duct off-sets above roof.

10. Type B-4C Restrained Non-isolated Curb with Sound Package

a. Manufacturer: Vibration Mounting and Control

b. Model: P6000 with SRPFMA sound package

c. Application: Frame supply and return air openings shall be provided in the sound isolation floor and the area between sound isolation floor and roof. Sound isolation floor to have supply and return duct openings with angle iron frame to matched to unit supply and return air openings. Provide air-tight connections between sound isolation floor openings and the respective opening on unit.

d. Isolation curb shall be as describe for Type B-4 above except as follows:

(i) Upper structural rail shall include an angle iron frame welded to the upper rail capable of supporting a continuous sound isolation floor.

(ii) Sound isolation floor shall be a "double-walled" panel consisting of a heavy gauge galvanized (G-90) sheet metal capable of spanning width of unit with 4 inches acoustical liner. Panel shall be capable of supporting 20 psf not weighting more than 6 psf. Sound isolation floor design shall provide an air-tight joint between panels.

(iii) Sound isolation floor shall be two (2) layers of 5/8 inch sheetrock. Sheetrock joints between layers shall be staggered and provided with a continuous seal of acoustical caulking.

(iv) In lieu of expanded metal perimeter walls, curb shall be provided with galvanized (G-90) sheet metal double-walled panels with 2 inches of insulation with a minimum "R" value equal to 12.

(v) Provide a flexible membrane within perimeter of the curb to provide air tight plenum seal and on both sides of plenum divider

(vi) Provide an insulated plenum divider (full width of curb) to divide the area between sound isolation floor and roof into a supply plenum and return plenum. Construction of plenum divider same as perimeter wall for curb.

e. Height of roof curb shall be adjusted so that the maximum velocity of the return air traveling through the cross sectional area between sound isolation floor and roof is equal to or less than return air ductwork or as required in Type B-3 for horizontal duct off-sets above roof.

11. Type B-5: Isolated Equipment Supports (Wind)

a. Manufacturer: Vibration Mounting and Control

(i) Model: R7100/7200/7300; Model per scheduled deflection requirements in Part 3

b. Equipment Support shall be custom designed to suit the approved equipment. HVAC Contractor to provide details of the approved equipment to manufacturer of equipment support and submit the shop drawings of the equipment support to the equipment manufacturer for approval.

c. Equipment support shall generally consist of:

(i) An upper floating structural rail designed for continuous support of unit and captive to resiliently resist wind forces for project location. Wind hold down to connect equipment to upper structural rail.

(ii) Spring isolators shall have characteristics as specified for Type "A" spring isolator, be laterally stable, rest on ¼ inch thick elastomeric and be color coded for proper identification. Spring shall be mounted in an accessible water-proof spring pockets to allow for spring removable and replacement and equipment to be level. Spring pockets shall contain combination horizontal and vertical restraints in conjunction with ¼ inch thick neoprene rubber bushing designed to resist seismic and wind forces at project location.

(iii) Lower continuous structural rail designed to accept point spring loads transferred from the equipment to the building structure. Lower structural rail shall include provisions to connect roof curb to building structure capable of resisting wind forces at project location.

(iv) Design of equipment load transfer to building structure shall be through roof curb contact point only.

(v) Perimeter walls shall be CCA grade plywood to protect structural rails to allow for proper flashing of support to roof system.

(vi) Provide reinforcing cross-bracing as required to support unit and resist wind forces.

(vii) Hardware shall be plated and springs shall be powder coated or cadmium plated.

(viii) Curb waterproofing shall be designed to meet all requirements of National Roofing Contractor Association (NRCA)

12. Type B-6: Non-Isolated Equipment Support (Wind)

a. Manufacturer: Vibration Mounting and Control

(i) Model: P7000

b. Equipment Support shall be custom designed to suit the approved equipment. HVAC Contractor to provide details of the approved equipment to manufacturer of equipment support and submit the shop drawings of the equipment support to the equipment manufacturer for approval

c. Non-isolated equipment support shall be as described for Type B-5 above except as follows:

(i) Upper structural rail shall not "float" but shall be unitized with the lower structural rail

(ii) Curb shall be designed to meet the seismic and wind force required for the project location.

13. Type B-8 Isolation Roof Curb

a. Manufacturer: Vibration Mounting and Controls

(i) Model: AXR Model

b. Roof curb shall be custom designed to suit the approved roof-top unit. HVAC Contractor to provide details of the approved roof-top unit to manufacturer of the roof curbs and submit the shop drawings of the roof curb to the roof-top unit manufacturer for approval.

c. Roof curb shall generally consist of:

(i) An extruded aluminum upper floating structural frame designed for continuous support of unit

(ii) Spring isolators shall have characteristics as specified for Type "A" spring isolator, be laterally stable, rest on ¼ inch thick elastomeric and be color coded for proper identification. Springs shall be mechanically fastened, sized and positioned for uniform deflection over entire system. Springs shall be zinc plated

(iii) Lower continuous structural rail designed to accept point spring loads transferred from the roof-top unit to the building structure. Lower structural rail shall include provisions to connect roof curb to building.

(iv) A continuous flexible seal shall connect the upper and lower rails to provide a water and air tight seal

(v) A closed-cell neoprene gasket bonded to the top of the upper rail and bottom of lower shall provide and air and water tight seal.

2.6 FLEXIBLE CONNECTORS

A. Type FC-1: Flexible Stainless Steel Hose

1. Flexible connector shall be a corrugated stainless steel hose with a protective stainless braid wire jacket.

2. Protective Jacket; Single/double/triple braid as required to meet system pressure

3. Flexible connect 2 ½ inch and smaller shall be a male nipple; 3 inch and larger flanged

4. Flexible connector working pressure; working pressure shall match working pressure of the piping system at the point of installation. See Division 23; Section titled "Hydronic Piping" for working pressure requirements at point of installation.

5. Design pressure shall be a minimum of 1.5 times working pressure.

B. Type FC-2: Flexible Bronze for Refrigerant Application

1. Seamless flexible tin/bronze tubing (suitable for use with Freon type system) with a protective bronze braided wire jacket.

2. Protective jacket; Less than 2 inch inside diameter shall be single braid; protective jacket piping systems 2 inch and larger double braid.

3. End connection; male wrought copper (solder type)

4. Working Pressure; Minimum equal to or greater than refrigerant pressure for system installed in.

5. Design pressure shall be a minimum of 1.5 times working pressure.

C. Minimum length of flexible connector

Pipe Size (inches)	Connector length (inches)
½	9
¾	10
1	11
1 ¼	12
1 ½	13
2	14

D. Hoses shall be installed on the equipment side of the shut-off valves horizontal and parallel to the equipment shaft wherever possible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. All areas that will receive components requiring vibration control shall be thoroughly examined for deficiencies that will affect their installation or performance. Such deficiencies shall be corrected prior to the installation of any such system.

B. All areas that will receive system/components requiring wind consideration shall be thoroughly examined for deficiencies that will affect their installation or performance. Such deficiencies shall be corrected prior to the installation of any such system/component.

C. Examine all "rough ins" including anchors and reinforcing prior to placement.

3.2 COMPONENT INSTALLATION, (General)

A. All vibration isolators and/or wind restraint (if required) systems must be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.

B. Installation of vibration isolators and/or wind restraints (if required) must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.

C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system specified herein.

D. The contractor shall not install any isolated equipment, piping, duct, conduit, etc. which makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beam, columns, studs and walls.

E. Coordinate work with other trades to avoid rigid contact with the building.

F. Over stressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. General bracing may occur from flanges of structural beams, upper truss cords in bar joist construction and cast in place inserts or wedge type drill-in concrete anchors.

G. Vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not permitted.

H. Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust in relation to the equipment weight. Horizontal thrust restraints shall be those described in the specification when horizontal motion exceeds 3/8."

I. Contractor responsibilities with respect to spring isolation curbs

1. Coordinate physical (height, width, length, weight, etc.) requirement with the roof curb manufacturer.

2. Coordinate size and location of unit supply and return openings

3. For spring isolation curbs Types B-3 & B-3A, Contractor shall carry the cost of furnishing and installing (by Contractor responsible for roofing system) 2 inches of rigid roof insulation around the perimeter of roof curb. Insulation shall be fastened to expanded metal in accordance with roof curb manufacturer recommendations.

4. For spring isolation curbs Types B-3B & B-3C, Contractor shall carry the cost of furnishing and installing (by Contractor responsible for roofing system) 4 inches of rigid roof insulation under the full “footprint” of Unit. In addition, Contractor shall seal the inside perimeter at the interface of the roof insulation and curb with a vapor barrier cement.

5. For spring isolation curbs Types B-3, B-3A & B-3B, insulate exterior of ductwork (supply and return) with 2 inches of Type D-2 board insulation from 6 inches below roof to underside of unit/sound isolation floor. See Division 23 Section titled “Duct Insulation” for insulation requirements.

6. For spring isolation curbs Types B-3B & B-3C, coordinate clearance within roof curb between the roof and underside for sound isolation floor to limit plenum velocity to a maximum of the return air duct velocity

7. Where supply and/or return ductwork exists from roof curb horizontally above roof, coordinate height of the roof curb to allow for the bottom duct to exist roof curb a minimum of 6 inches above roof with curb manufacturer.

8. Where drawings have a height requirement for roof curb, coordinate height with curb manufacturer.

J. Contractor responsibilities with respect to non-isolated curbs

1. Coordinate physical (height, width, length, weight, etc.) requirement with the roof curb manufacturer.

2. Coordinate size and location of unit supply and return openings

3. For spring isolation curbs Types B-4 & B-4A, Contractor shall carry the cost of furnishing and installing (by Contractor responsible for roofing system) 2 inches of rigid roof insulation around the perimeter of roof curb. Insulation shall be fastened to expanded metal in accordance with roof curb manufacturer recommendations.

4. For spring isolation curbs Types B-4B & B-4C, Contractor shall carry the cost of furnishing and installing (by Contractor responsible for roofing system) 4 inches of rigid roof insulation under the full "footprint" of Unit. In addition, Contractor shall seal the inside perimeter at the interface of the roof insulation and curb with a vapor barrier cement.

5. For spring isolation curbs installed on pitched roofs, furnish and installed steel stub support posts (varying heights to suit roof pitch) from curb manufacturer to allow roof curb to be set level. Steel stub support posts shall be welded to building structure and lower structural rail per curb manufacturer's recommendations to meet seismic requirements.

6. For spring isolation curbs Types B-4, B-4A & B-4B, insulate exterior of ductwork (supply and return) with 2 inches of Type D-2 board insulation from 6 inches below roof to underside of unit/sound isolation floor. See Division 23 Section titled "Duct Insulation" for insulation requirements.

7. For spring isolation curbs Types B-4B & B-4C, coordinate clearance within roof curb between the roof and underside for sound isolation floor to limit plenum velocity to a maximum of the return air duct velocity

8. Where supply and/or return ductwork exists from roof curb horizontally above roof, coordinate height of the roof curb to allow for the bottom duct to exist roof curb a minimum of 6 inches above roof with curb manufacturer.

9. Where drawings have a height requirement for roof curb, coordinate height with curb manufacturer.

K. All equipment, piping, etc. shall be mounted on or suspended from approved foundations and supports, all as specified herein, or as shown on the drawings.

L. All rigidly or resiliently installed equipment, piping, etc., shall be capable of accepting wind forces acting in a perpendicular direction on the equipment center of gravity without permanent displacement of the equipment from the installed position.

M. All concrete foundations and supports (and required reinforcing and forms) will be furnished and installed by Contractor responsible for the work of Division 03. However, this Contractor shall furnish shop drawings showing adequate concrete reinforcing steel details and templates for all concrete foundations and supports, and all required hanger bolts and other appurtenances necessary for the proper installation of his equipment. Although the Contractor responsible for the work of Division 03 will complete all concrete work, all such work shall be shown in detail on the shop drawings, prepared by this Contractor which drawings shall be submitted showing the complete details of all foundations including necessary concrete and steel work, vibration isolation devices, etc.

N. All floor-mounted equipment shall be erected on a minimum of 4" high concrete pads over the complete floor area of the equipment, unless specified to the contrary herein. Wherever hereinafter vibration eliminating devices and/or concrete inertia blocks are specified, these items shall, in all cases, be in turn mounted upon 4" high concrete pads unless specified to the contrary herein. These pads shall be integrally keyed to structural slab.

O. The vibration isolation systems shall be guaranteed to have the deflection indicated in the schedule in Part 3 of this section. Mounting sizes shall be determined by the mounting manufacturer, and the sizes shall be installed in accordance with the manufacturer's instructions.

P. All mounting systems including wind restraints exposed to weather and other corrosive environments shall be protected with factory corrosion resistance. All metal parts of mountings (except springs and hardware) to be hot dip galvanized. Springs shall be cadmium plated and neoprene coated. Nuts and bolts shall be cadmium plated.

Q. Each wind restraint, snubbing device or isolation mounting incorporating wind restraint shall be installed and/or adjusted to provide the minimum operating clearance in all directions to permit the operation of the equipment without objectional noise or vibration to any part of the building structure.

R. Provide all necessary supports for equipment furnished as part of the work of this Division. To meet the varying conditions in each case, these supports shall consists of pipe stands, steel angle or strap hangers, saddles, brackets, etc., as approved. All such supports shall have substantial flanges bolted to floor construction; hangers shall be supported from the framing as described herein above. Supports shall be properly located with reference to any supporting pads, legs, etc., of the equipment carried and must be of such number and so distributed as not to bring any undue strains to the equipment. All details shall be as approved.

S. Provide suitable brackets, pipe stands, piers or other supports for all various ductwork accessories and appurtenances, piping system accessories and appurtenances, electrical system accessories and appurtenances, etc. Also provide suitable supports for all tempering stacks, air filters, mixing and control dampers, etc., securely clamped to steel beams, column or bearing walls. All details of this work shall be as approved. Guarantee that the work as installed under this section of the specifications will not result in the transmission of objectionable noise or vibration to any occupied parts of the building, and take full responsibility for any necessary modifications of this equipment, or of the foundations and supports for the same, necessary to secure this result.

T. All vibration isolators and wind restraint (if required) systems must be installed in strict accordance with manufacturer’s written instructions and all certified submittal data.

U. Coordinate work with other trades to avoid rigid contact with building.

V. Correct, at no additional cost, all installations which are deemed defective in workmanship and material.

W. Where piping and conduits pass through walls, floor, or ceiling, the Contractor shall provide wall seals or resilient packed sleeves.

3.3 EQUIPMENT INSTALLATION

A. All equipment shall be provided with equipment bases and/or vibration isolation per Tables A through D.

B. Buildings, that require wind consideration, shall be provided with restraint systems to resist wind forces, in addition to the equipment bases and/or vibration isolation required in subparagraph "A" above. Restraint system shall be design, selected, specified, reviewed (shop drawing) and inspected by the Licensed Professional Engineer engaged by the Contractor responsible for the work of Division 23.

C. Place floor mounted equipment on 4" high concrete housekeeping pads properly sized and doweled or expansion shielded to the structure. Anchor isolators and/or bases to housekeeping pads. Concrete work is specified in Division 03 of the contract documents.

D. Additional Requirements

1. The minimum operating clearance under all isolated components bases shall be 2."

2. All bases shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the equipment, isolators and restraints.

3. The equipment shall be installed on blocks to the operating height of the isolators. After the entire installation is complete and under full load including water, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. Remove all debris from beneath the equipment and verify that there are no short circuits of the isolation. The equipment shall be free to move in all directions, within the limits of the restraints.

3.4 PIPING AND DUCTWORK ISOLATION

A. Vibration Isolation of Piping

1. HVAC Water Piping

2. Fire Protection Systems Piping

a. No isolators required

B. Wind Restraint of Piping, Conduit, Bus Duct, Cable trays, etc.

1. Buildings, that require wind consideration, shall be provided with restraint systems to resist wind forces in addition to vibration isolation required in subparagraph titled “vibration isolation of piping” above. Restraint system shall be design, selected, specified, reviewed (shop drawing) and inspected by the Licensed Professional Engineer engaged by the Contractor responsible for the work of this Division.

C. Vibration Isolation of Ductwork

1. All discharge runs for a distance of 50' from the connected equipment shall be isolated from the building structure by means of Type E combination spring elastomer hanger or Type A floor spring isolators. Spring deflection shall be a minimum of 0.75".

2. All duct runs having air velocity of 1500 feet per minute (fpm) or more shall be isolated from the building structure by Type E combination spring elastomer hangers or Type A floor spring supports. Spring deflection shall be a minimum of 0.75"

3. Wind Restraint of Ductwork

a. Buildings, that require wind consideration, shall be provided with restraint systems to resist wind or forces in addition to vibration isolation required in subparagraph titled “vibration isolation of ductwork” above. Restraint system shall be design, selected, specified, reviewed (shop drawing) and inspected by the Licensed Professional Engineer engaged by the Contractor responsible for the work of Division 23.

3.6 FIELD QUALITY CONTROL, INSPECTION

A. Upon completion of installation of all vibration isolation devices, the local representative shall inspect the completed project and certify in writing to the Contractor that all systems are installed properly, or require correction. The Contractor shall submit a report to the Architect, including the representative's report, certifying correctness of the installation or detailing corrective work to be done.

3.7 EQUIPMENT VIBRATION ISOLATION SCHEDULES (NON-SEISMIC)

A. The following schedules (Tables A through D) are applicable to Systems/Components that are not required by Code to be seismically restrained.

1. Vibration isolator type, deflection and base type have been reviewed and approved by Project Acoustical Consultant.

B. Abbreviations applicable to Schedules (Tables A through D)

1. MISC. INFO. Miscellaneous Information

2. EQUIP. MTNG. Equipment Mounting

3. ISOL. TYPE Vibration Isolation Type

4. DEFL. Deflection

HVAC EQUIPMENT VIBRATION ISOLATION SCHEDULE TABLE A (NON-SEISMIC)								
EQUIPMENT LOCATION			SLAB ON GRADE OR BASEMENT SLAB ON GRADE			STRUCTURAL SLAB (SUSPENDED)		
Equipment Type	Misc. Info.	Equip. Mtng.	Isolation Type	Defl (Inches)	Base Type	Isolation Type	Defl (Inches)	Base Type
Air Handling Units (indoor)	--	Floor	B	0.75	--	B	1.5	--
		Ceiling	--	--	--	E	1.0	--
Condensers, Condensing Unit, Etc	--	Grade/ Roof	--	--	--	B	2.0 minimum	B-5
Axial Fans	--	Floor	B	0.75	--	B	See Equip Guide	--
	--	Ceiling	--	--	--	E -2	See Equip Guide	--
Plug Fans	Class 1 & 2	Ceiling	E-2	See Guide	--	E-2	See Equip Guide	--
Plenum Fans	Class 1	Floor	B	0.75	--	B	See Equip Speed Guide	--
	Class 2 & 3	Floor	B	0.75	--	B	See Equip Speed Guide	--
Centrifugal Fans Arrangement 1 & 3	Class 1	Floor	B	0.75	B-1	B	See Equip Speed Guide	B-1

HVAC EQUIPMENT VIBRATION ISOLATION SCHEDULE TABLE A (NON-SEISMIC)								
EQUIPMENT LOCATION			SLAB ON GRADE OR BASEMENT SLAB ON GRADE			STRUCTURAL SLAB (SUSPENDED)		
Equipment Type	Misc. Info.	Equip. Mtng.	Isolation Type	Defl (Inches)	Base Type	Isolation Type	Defl (Inches)	Base Type
	Class 2 & 3	Floor	B	0.75	B-2	B	See Equip Guide	B-2
	Class 1	Ceiling	--	--	--	E-2	See Equip Speed Guide	B-1
Centrifugal Fans Arrangement 9,10 & Vent Sets	Class 1	Floor	B	0.75	--	B	See Equip Speed Guide	B-1
	Class 2 & 3	Floor	B	0.75	B-2	B		B-2
	--	Ceiling	--	--	--	E-2		--
	--	Roof	--	--	--	--		B-5
Cabinet Fans	1 HP or Less	Floor	F	0.2	--	B	0.75	--
		Ceiling	--	--	--	E-2	0.75	--
	Greater Than 1HP	Floor	B	0.75	--	B	See Equip Speed Guide	--
		Ceiling	--	--	--	E-2	See Equip Speed Guide	--
Curb Mounted Equipment (non-isolated)	--	Roof	--	--	--	--	--	B-6
Non -isolated Equipment		Floor	--	--	--	--	--	--
Condensate Pumps	--	Floor				F	0.2	if Required

HVAC EQUIPMENT VIBRATION ISOLATION SCHEDULE TABLE A (NON-SEISMIC)								
EQUIPMENT LOCATION			SLAB ON GRADE OR BASEMENT SLAB ON GRADE			STRUCTURAL SLAB (SUSPENDED)		
Equipment Type	Misc. Info.	Equip. Mtng.	Isolation Type	Defl (Inches)	Base Type	Isolation Type	Defl (Inches)	Base Type
Fan Coil Unit (incremental)	--	Floor	--	--	--	--	--	--
	--	Ceiling	--	--	--	D	1.0	--
Unit Heaters	--	Ceiling	--	--	--	D	0.75	--
Cabinet Heater	--	Floor	--	--	--	--	--	--
	--	Ceiling	--	--	--	D	0.75	--
Roof Top Air Cooled Air Conditioning Unit	10 Tons or Less	Roof	--	--	--	--	1.5	See Note 3
	Greater than 10 Tons	Roof	--	--	--	--	2.0	See Note 3
Roof Top Air Handling Unit	--	--	--	--	--	--	1.0	B-5

EQUIPMENT SPEED GUIDE (MINIMUM ISOLATOR DEFLECTION) SCHEDULE EQUIPMENT LOWEST OPERATING SPEED (RPM)	DEFLECTION (INCHES)
Less than 400	3.5
401 t0 600	2.5
601 to 900	2.0
Greater than 900	1.0

Note: The Equipment Speed Guide is applicable to equipment in Table "A"

1. For equipment with the designation “See Guide,” use Equipment Speed Guide for required deflection.

2. Base Type B-5 (vibration isolated equipment) shall be used. Base Type B-6 (non-vibration isolated equipment) shall be used.

3. Based Type B-3 shall be used for Roof Top Air Cooled Air Conditioning Units for projects where the roof deck under the unit is either a concrete slab of concrete over a metal deck and supply and return ductwork is directly connected to unit.

4. The following base types shall be used for Roof Top Air Cooled Air Conditioning Units for projects where there is only a metal deck under the unit

    a. Base Type B-3A for unit where the supply and return ductwork is directly connected to unit.

    b. Base Type B-3B for units where the supply ductwork is directly connected to the unit and the area below the unit and above the roof deck is used as a return air plenum.

    c. Base Type B-3C for units where the area below the unit and above the roof deck is used as supply air plenum and a return air plenum.

5. Based Type B-4 shall be used for Roof Top Air Cooled Air Conditioning Units for projects where vibration isolation of unit is not required and the roof deck under the unit is either a concrete slab of concrete over a metal deck and supply and return ductwork is directly connected to unit.

6. The following base types shall be used for Roof Top Air Cooled Air Conditioning Units for projects where vibration isolation of unit is not required and there is only a metal deck under the unit.

    a. Base Type B-4A for unit where the supply and return ductwork is directly connected to unit.

    b. Base Type B-4B for units where the supply ductwork is directly connected to the unit and the area below the unit and above the roof deck is used as a return air plenum.

    c. Base Type B-4C for units where the area below the unit and above the roof deck is used as supply air plenum and a return air plenum.

7. Equipment (for example air handling) not suitable for point support that requires external vibration isolation, provide Type B-1 equipment base for the entire unit. For deflection see “equipment Speed Guide Schedule” based on lowest operating speed.

8. Deflections indicated are minimum at actual load. Actual spring deflection shall be selected for manufacturer’s nominal deflection (1, 2, 3, 4 & 5 inches) spring series. Equipment speed (RPM) is defined as lowest operating speed.

9. Curb mounted fans that require a floor area of less than 9.0 square feet are excluded.

10. For equipment with multiple motors, horsepower classifications apply to largest single motor.

PLUMBING EQUIPMENT VIBRATION ISOLATION SCHEDULE TABLE B (NON-SEISMIC)								
EQUIPMENT LOCATION			SLAB ON GRADE OR BASEMENT SLAB ON GRADE			STRUCTURAL SLAB (SUSPENDED)		
Equipment Type	Misc. Info.	Equip. Mtng.	Isolation Type	Defl (Inches)	Base Type	Isolation Type	Defl (Inches)	Base Type
Domestic Water Heaters	--	Floor	--	--	--	--	--	--

ELECTRICAL EQUIPMENT VIBRATION ISOLATION SCHEDULE TABLE C (NON-SEISMIC) INSTALLATION ATTACHMENT POINT								
EQUIPMENT LOCATION			SLAB ON GRADE OR BASEMENT SLAB ON GRADE			STRUCTURAL SLAB (SUSPENDED)		
Equipment Type	Misc. Info.	Equip. Mtng.	Isolation Type	Defl (Inches)	Base Type	Isolation Type	Defl (Inches)	Base Type
Transformer (Dry Type)	Up to 150 KVA	Floor	--	--	--	B	1	--
		Ceiling	--	--	--	E-2	1	--
Emergency Generator	All Sizes	Floor	B	1	--	--	--	--
Uninterruptible Power Supply (UPS)	All Sizes	Floor	F	0.2	--	B	2.0	--
Transformer (Dry Type)	Greater than 150 KVA	Floor	--	--	--	B	1	--

END OF SECTION 23 05 47

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SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING, DUCTWORK AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.3 ACTION SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Lamacoid Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

2. Letter Color: White

3. Background Color: Black.

4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering. (1/2" letters for rooftop equipment, ¼" letters for above ceiling equipment)

7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

J. Signs and labels shall meet requirements of ASTM 709, Type I.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction conforming with ASME A13.1.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic (or stickers) labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Black.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches (38 mm) high.

3. Conform with requirements of ASTM A 13.1.

2.5 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches (32 mm) for ducts; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Fiberboard.

2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.

3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.6 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: Brass, 0.032-inch (0.8-mm) minimum thickness and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.7 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.

2. Fasteners: Brass grommet and wire.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.

2. Stencil Paint: Use for pipe marking.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

1. Refrigerant Piping:

a. Background Color: Blue.
b. Letter Color: White.

3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

1. BlueFor exhaust-, outside-, relief-, return-, and mixed-air ducts.

2. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1 inch (25 mm) high is needed for proper identification because of distance from normal location of required identification.

C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet (15 m) in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:
a. Refrigerant: 2 inches (50 mm), round.

2. Valve-Tag Color:
a. Refrigerant: Natural.

3. Letter Color:
   a. Refrigerant: Black.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 23 05 53

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SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Testing, adjusting, and balancing of Air Systems.

B. Measurement of final operating conditions of HVAC Systems.

C. Sound measurement of equipment operating conditions.

D. Vibration measurement of equipment operating conditions.

E. Measurement of the IAQ after the completion of the final balancing.

1.3 SCOPE OF WORK

A. General:

1. Testing, adjust and confirm design airflows rates, pressure drops, pressures, temperatures and heat transfer performance for HVAC systems, including, but not limited to supply air, return air and exhaust air systems, including all associated coils, fans, dampers, diffusers, terminal devices, and accessories.

2. Provide all necessary labor, materials, products, equipment and services to balance and test all HVAC systems, to verify conformance to specified quantities, and to the design intent of the mechanical system and for the testing of all the fire safety systems.

3. Cooperate with all other trades, including, but not limited to, building controls, fire alarm, sheetmetal and piping sub-contractors to ensure the Work is carried out without interference to other Work.

4. Provide openings required for pitot tube traverses. After balancing, close openings with removable gasketed plugs. Submit samples of proposed plugs for approval.

5. Conduct routine inspections during the mechanical systems installation and report on poor ductwork installation (likely to produce abnormal leakage), poor piping installation, poor placement of dampers, and any circumstance which will encumber the balancing of the mechanical systems.

6. Review Drawings and Specifications and ensure that adequate provisions are made in the mechanical installation to facilitate the balancing of all air systems; make recommendations to the Architect/Engineer where additional measures may be required.

7. Include all items of labor, materials, products, equipment and devices required to comply with such standards and codes in accordance with the contract documents to balance all air and hydronic systems, to verify conformance to specified quantities and to the design intent of the mechanical system. Where quantities, sizes or other requirements indicated on the drawings or herein specified are in excess of the standard or code requirements, the specifications and drawings shall govern.

1.4 REFERENCES

A. ASHRAE - Standard 111 - 1988 Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air Conditioning, and Refrigeration Systems.

B. ASHRAE - 1987 HVAC Systems and Applications Handbook: Chapter 57, Testing, Adjusting and Balancing.

C. AABC- National Standards for Total System Balance.

D. NEBB - Procedural Standards for Testing, Balancing and Adjusting of Environmental System.

E. SMACNA - HVAC System Testing, Adjusting and Balancing.

F. Sheet Metal Industry - Certification of Testing, Adjusting and Balancing Technicians.

1.5 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

F. Systems testing, adjusting, and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:

1. The balance of air distribution;

2. Adjustment of total system to provide design quantities; verification of performance of all equipment and automatic controls;

3. Sound and vibration measurement.

4. IAQ measurements

G. Test: To determine quantitative performance of equipment.

H. Adjust: To regulate the specified air patterns at the terminal equipment (e.g., reduce fan speed, throttling).

I. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.

J. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.

K. Report forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.

L. Terminal: The point where the controlled fluid enters or leaves the distribution system. These are supply outlets on air terminalsand exhaust or return inlets on air terminals such as registers, grilles, diffusers, and hoods.

M. Main: Duct containing the system's major or entire fluid flow.

N. Submain: Duct containing part of the systems' capacity and serving two or more branch mains.

O. Branch main: Duct serving two or more terminals.

P. Branch: Duct serving a single terminal.

1.6 ACTION SUBMITTALS

A. LEED Submittals:

1. Air-Balance Report for Prerequisite IEQ 1: Documentation of work performed for ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

2. TAB Report for Prerequisite EA 2: Documentation of work performed for ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

B. Procedures: Furnish submittals in accordance with the general requirements of the Contract Documents.

C. Activity Programs: The Air Balance contractor shall prepare and submit for approval a detailed activity program. The program shall be in accordance with the overall Construction Schedule.

1. Specific requirements included within the activity program shall be:

a. Required dates for the acceptance of system/equipment from the installing contractor "ready for balance".
b. Required Periods for the individual system balancing.
c. Requirements for attendance from the installing contractor and their suppliers.

2. Activity Programs shall be prepared for each major system and/or specific item of equipment.

D. Certified Test Reports: Furnish test results and a schematic layout for each system, certified by the Contractor. Six completed copies including schematic layouts, shall be submitted to the Owner. Balancing report submitted shall list each grille, register and diffuser associated with each system, giving numerical identification (including room number or area name), design quantity, final quantity, etc., and design power requirements for all supply and exhaust fans and actual operating conditions listing RPM, volts, amps, kw, etc., in accordance with AABC/NEBB/TABB test report forms. Include identification and types of instruments used and their most recent calibration date with test reports.

1. General

a. Provide a complete balancing report in 3-ring binder manuals. Report should include contents, page and index tabs and cover identification at front and side.
b. Include types, serial number and dates of calibration of test instruments. (Submit calibration certificates).
c. Record test data on a sepia made from the latest available revised set of mechanical drawings and submit six (6) copies upon completion of the balancing contract.
d. Install at each piece of mechanical equipment a "Data Register" showing significant operating temperatures, pressures, amperes, voltage frequency, motor KW, FLA, belt size/model number and sheave size. "Data Register" to be enclosed in a plastic holder securely attached to the equipment or to a wall in the adjacent area.
e. Submit with report, fan curves with operating conditions plotted. Submit grille and diffuser shop drawings and diffusion factors.
f. Submit with the report schematics of all the air systems.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 45 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports.

E. Sample report forms.

F. Instrument calibration reports, to include the following:

1. Instrument type and make.

2. Serial number.

3. Application.

4. Dates of use.

5. Dates of calibration.

1.8 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB, or TABB. The entity shall be an independent testing, adjusting and balancing entity, single source of responsibility to test adjust and balance building systems to produce design objectives. Services shall include checking installation for conformity to design, measurement and establishment of capacities of the mechanical systems as required to meet design specifications and recording and reporting the results. The entity shall have at least one Professional Engineer registered in the State in which the services are to be performed and certified by NEBB or AABC as a Testing and Balancing Engineer.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.

2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.

B. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB contractor's forms approved by Owner Construction Manager or Commissioning Authority.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

G. The air balance agency shall provide proof of having at least 5 years testing, adjusting and balancing experience, as well as having successfully completed at least five projects of similar size and scope.

H. The work must be performed by a Certified Testing, Adjusting and Balancing Technician who may be assisted by other TAB Technicians under the supervision of the TAB Field Supervisor. The Certified Testing, Adjusting and Balancing Technician is responsible for:

1. Procedures to be followed
2. Accuracy of all testing
3. Integrity of recorded data
4. Entering all data and reporting any abnormal or notable conditions on the report forms
5. Initialing and dating each sheet

I. The General Section of the Balance Report shall include the names, signatures, and registration numbers of the Technicians who were assigned to the project. The Balancing Report shall also include the signature and registration number of the Professional Engineer and a statement that he has reviewed and approve the report.

J. Codes and Standards:

1. NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
2. AABC: "National Standards For Total System Balance".

K. Contractor's Quality Assurance Responsibilities: This Contractor is solely responsible for quality control of the Work. Comply with the general requirements of the contract.

L. IAQ Testing Agency Qualifications:

1. The testing and balancing agency shall employ the services of an independent IAQ testing agency to test the building air systems identified above, to produce an IAQ report.
2. In conjunction with the testing and balancing agency, the IAQ testing agency's services shall include checking installations for conformity to design, measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications and recording and reporting the results.
3. The independent testing agency shall be certified by a National entity jurisdiction in IAQ testing disciplines required for this project and having at least one Professional Engineer registered in the State in which the services are to be performed.
4. The testing agency shall provide proof of having at least 5 years testing experience, as well as having successfully completed at least five projects of similar size and scope.
5. The work must be performed by a Certified Technician who may be assisted by other Technicians. The Certified Technician is responsible for:

a. Procedures to followed
b. Accuracy of all testing
c. Integrity of recorded data
d. Entering all data and any abnormal or notable conditions in report forms
e. Initialing and dating each sheet

6. The General Section of the Report shall include the names, signatures, and registration numbers of the Technicians who were assigned to the project.

1.9 PROJECT CONDITIONS

A. General: Do not proceed until systems requiring testing, adjusting and balancing are clean and free from debris, dirt, and discarded building materials.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

C. Air balance and testing shall not begin until system has been completed and is in full working order. The mechanical contractor shall put all heating, ventilating and air conditioning systems and equipment into full operation and shall continue the operation of same during each working day of testing and balancing.

1.10 COORDINATION

A. Notice: Provide ten working days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air distribution systems have been satisfactorily completed.

1.11 HVAC CONTRACTOR RESPONSIBILITIES

A. Prepare each system for testing and balancing

B. Cooperate with the testing agencies, provide access to all work, equipment and systems.

C. Put all heating, ventilating and air conditioning systems and equipment into full operation and shall continue the operation of same during each working day of testing and balancing. Operate systems and under conditions required for proper testing, adjusting, and balancing.

D. Notify Testing Agency’s project manager, Owner and Engineer seven days prior to time system will be ready for testing, adjusting, and balancing. Project readiness shall include:

1. Systems are started and running (fans have been checked for proper rotation).

2. Permanent electrical power wiring is complete.

3. Verification that all ductwork is fabricated and installed as specified.

4. Ceilings are installed in critical areas where air pattern adjustment may be required. Access to balancing devices are provided.

5. All equipment and ductwork access doors are securely closed.

6. All balancing dampers are installed and in full open positions.

7. Rotating equipment (fans, etc.) have been statically and dynamically balanced at the factory. HVAC Contractor shall verify that equipment 10 Horsepower and greater has not become un-balanced either during shipping or installation of the equipment. HVAC Contractor shall report equipment found un-balanced to the Architect/Engineer/Owner and rebalance equipment prior to commence of the Testing, Adjusting and Balancing Work.

8. The HVAC Contractor shall coordinate the leakage testing of ductwork with the Testing and Balancing Contractor, to ensure that the duct testing is done in a timely manner so as not to interfere with the progress of the work

9. All ductwork etc. That is found is found to exceed the permissible leakage rates shall be immediately repaired by the HVAC Contractor, at no additional cost and in a timely manner so as not to interfere with the progress of the work.

10. System installation is complete, with Controls and Instrumentation installed and fully operational.

1.12 SEQUENCING AND SCHEDULING

A. Sequencing work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

1.13 DRAWING AND CONSTRUCTION REVIEW

A. Perform a preconstruction review of the following documents:

1. Updated construction drawings

2. Contract specifications

3. Addenda

4. Submittal data

5. Shop drawings

6. Automatic Control drawings

B. Prepare a report of the preconstruction review list of recommended changes to allow most effective balancing.

C. Perform four construction reviews of the mechanical installation during the progress of the project. Purpose of the reviews to be:

1. Identify potential problems for performing balancing.

2. Identify modifications which will aid balancing.

3. Schedule and coordinate balancing with other work and other trades.

D. Prepare a report of each construction review.

E. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with the Architect/Engineer and representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS

A. HVAC Contractor shall, at the time of his bid, shall submit the name of the Testing and Balancing Contractors (TBC).

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 23 31 13 "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan curves.

1. 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.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units and verify that they are accessible and their controls are connected and functioning.

K. Examine operating safety interlocks and controls on HVAC equipment.

L. Equipment is operable and in safe and normal condition.

M. Temperature control systems are installed complete and operable.

N. Proper thermal overload protection is in place for electrical equipment.

O. Pre and final filters are clean and in place.

P. Duct systems are clean of debris.

Q. Correct fan rotation.

R. All volume dampers are in place and are in the full open position.

S. Access doors are installed and closed and duct end caps are in place.

T. Terminal devices and air outlets are installed, connected and accessible and adjusted for full maximum flow.

U. Duct system leakage has been minimized. All duct systems requiring Leakage Tests have been tested and accepted.

V. Promptly report abnormal conditions in mechanical systems or conditions which prevent system balance.

W. If, for design reasons, system cannot be properly balanced, report as observed.

X. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

Y. Commence of the Testing, Adjusting and Balancing work means that the Testing and Balancing Contractor has reviewed and accepts that the HVAC System as installed.

3.3 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.

2. Automatic temperature-control systems are operational.

3. Equipment and duct access doors are securely closed.

4. Balance dampers are open.

5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

6. Windows and doors can be closed so indicated conditions for system operations can be met.

C. Prior to commence of Testing, Adjusting and Balancing Work, Testing and Balancing Contractor shall inspect all rotating equipment (fans, etc.) to verify that equipment is statically and dynamically balanced. If equipment is found to be un-balanced, Contractor shall report deficient equipment to Architect/Engineer/Owner. Testing, Adjusting and Balancing work shall not proceed on system until deficient equipment is correct.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section. The Testing and Balancing Contractor shall submit, along with his bid proposal for the Testing and Balancing work, the procedure for testing and balancing that he proposes to use.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts, or if required:

2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 "Air Duct Accessories."

3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 13 "Duct Insulation" and Section 23 07 19 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. Check airflow patterns from the outdoor-air intakes and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

K. Verify that air duct system is sealed as specified in Section 23 31 13 "Metal Ducts."

3.6 PROCEDURES FOR AIR HANDLING SYSTEMS

A. Air Distribution Systems: Operate the air handling systems and make adjustments in the controls and equipment as required to balance the systems to deliver the required design air quantities and temperatures.

1. Air Handling Systems:

a. First set of air filters shall be in place whenever fans are run. Replace with clean set of specified filters before testing.

b. Run supply fan with all dampers in their normal position (minimum outside air). Duplicate normal conditions as far as possible with clean filters in place, coils in operation, etc. Adjust for proper ratio of outside and return air.

2. NC (Noise Criteria) Tests: Operate the air handling systems after balancing, to determine that the schedule NC ratings in the spaces are not exceeded.

B. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as heat-recovery equipment, and air filters, under final balanced conditions.

5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, and any other operating mode to determine the maximum required brake horsepower.

6. Test and adjust fan RPM to design requirements.

7. Test and record motor load in amperages at various filter percentages.

8. Test and adjust systems for design return air flow.

9. Test and record system static pressures suction and discharge.

10. Test and adjust systems for design outside air.

11. Test and record entering air temperatures (DB & WB). (Mixed air, preheat coils, cooling coil, heating coil).

12. Test and record leaving air temperatures (DB & WB). (Preheat coil, cooling coil, heating coil).

C. Room air terminal devices.

1. Adjust volume dampers for main duct, submain ducts, and branch ducts to indicated airflows within specified tolerances.

a. Measure airflow of mains, submain and branch ducts.

(i) Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

b. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

c. Remeasure each main, submain and branch duct after all have been adjusted. Continue to adjust main, submain and branch ducts to indicated airflows within specified tolerances.

2. Measure air outlets and inlets without making adjustments.

a. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

3. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

4. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

5. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 OUTDOOR AIR SUPPLY SYSTEMS:

A. Note: Outdoor air supply systems must be balanced with General Exhaust and Toilet Exhaust systems operating at their design levels.

B. Test and adjust fan RPM to design requirements.

C. Verify correct fan rotation.

D. Test and record motor load in amps in various flow rate percentages.

E. Make pitot tube traverses of main supply ducts to determine fan delivery. Measure design flow at 50% dirty filter condition (simulate).

F. Measure the static pressure profile of the air handling unit and system duct static pressure at selected points (minimum of 10) throughout the system, including points along the vertical riser shafts.

G. After adjustments to dampers throughout the system have been made, re-check fan performance adjusting as necessary.

H. Mark all damper settings.

I. For systems with terminal boxes, follow procedure outlined in previous sub-paragraph for balancing terminal boxes in air handling systems.

3.8 PROCEDURE FOR FAN SYSTEMS (EXHAUST)

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

B. Measure total airflow.

1. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

4. Test and adjust fan RPM to design requirements

5. Test and record motor amperage for each phase leg

6. Verify fan rotation

C. Room air terminal devices

1. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

2. Measure airflow of main, submain and branch ducts.

   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

3. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

4. Remeasure each main, submain and branch duct after all have been adjusted. Continue to adjust main, submain and branch ducts to indicated airflows within specified tolerances.

5. Measure air outlets and inlets without making adjustments.

   a. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

6. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

7. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

8. Adjust patterns of adjustable outlets for proper distribution without drafts.

9. Corresponding supply air systems shall be operating at their design levels during the testing and balancing of return and exhaust systems.

10. Mark all damper settings.

3.9 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.

2. Motor horsepower rating.

3. Motor rpm.

4. Efficiency rating.

5. Nameplate and measured voltage, each phase.

6. Nameplate and measured amperage, each phase.

7. Starter thermal-protection-element rating.

B. Motors Driven by ECM control: Test for proper operation at speeds varying from minimum to maximum. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.10 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record compressor data.

3.11 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.

2. Airflow.

3. Entering- and leaving-air temperature at full load.

4. Voltage and amperage input of each phase at full load and at each incremental stage.

5. Calculated kilowatt at full load.

6. Fuse or circuit-breaker rating for overload protection.

B. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.

2. Wet-bulb temperature of entering and leaving air.

3. Airflow.

4. Air pressure drop.

3.12 Refrigerant suction pressure and temperature.TOLERANCES

A. Set HVAC system's air flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 5 percent.

2. Air Outlets and Inlets: Plus or minus 5 percent Where Multiple air outlets serve a single space, tolerance for total shall be plus 5 minus 10 percent.

3.13 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.14 INDOOR AIR QUALITY TESTING

A. Equipment Specification:

1. An infrared photo acoustic analyzer shall be used to monitor for carbon dioxide, carbon monoxide, and total volatile organic compounds levels. It is a real time analyzer equipment. The sampling installation in the building shall extend into the outside air, supply air and return air of each central HVAC system. In tenant areas the sampling points shall be as close as possible to the occupants breathing zones.

2. Calibration shall be performed in accordance with manufacturer specifications and recommended procedures.

B. Application (Analytical Methodology)

1. The analytical method used shall be a direct reading of the infrared spectroscopy technique, which classifies different organic compounds by their ability to absorb energy of specific wavelengths in the infrared region, specifically, center wavelength 3.4 μm and 3.6 μm respectively, as well as determine carbon dioxide and carbon monoxide in parts per million (ppm). The sub detection levels of the instrument, in parts per million (ppm) and milligrams per cubic meter (mg/m3), shall be as follows:

   a. Carbon dioxide ≈ 1.7 ppm;
   b. Carbon monoxide ≈ 0.2 ppm;
   c. Total volatile organic compounds, center wavelength 3.4 μm = 0.036 mg/m3. The instrument is calibrated for propane at this wavelength. The detection level of this filter is sensitive to changes in relative humidity.
   d. Total volatile organic compounds center wavelength 3.6 μm = 0.07 mg/m3. The instrument is calibrated for formaldehyde at this wavelength.

C. Indoor Air Quality Periodic Testing - Tenant Space

1. Two different sampling strategies shall be used, time specific sampling and 24 hour Continuous Monitoring.

2. The first strategy shall be the collection of indoor gaseous air quality data from a floor at a specific point in time (known as Time Specific Sampling), providing a snapshot of ambient conditions which are to be compared to applicable indoor air quality standards for verification of compliance with operating parameters.

3. The second strategy (known as 24-Hour Continuous Monitoring) expands upon the first through the use of additional equipment and provides a 24-hour study of conditions on the floor. The enhanced data produced by this configuration provides a more comprehensive view of ambient conditions and can record transient conditions that occur any time during monitoring. A graphical representation of gas concentrations over the sampling period is provided as part of the report.

D. Time-Specific Sampling

1. Indoor Gaseous Air Quality Monitoring for carbon dioxide (CO2), carbon monoxide (CO) and two classes of total volatile compounds (TVOC) utilizing air sampling and the Infra-red Photo acoustic Multi-Gas Analyzer shall be performed at 4 locations on each floor or every 10,000 feet, whichever is smaller as well as at the central HVAC equipment. This survey shall also include a visual inspection of the MER for parameters adversely affecting indoor air quality. The inspection should be focused on mechanical hygiene and should follow the parameters dictated by EPA's guidelines such as the "Building Air Quality: A Guideline For Building Owners and Facilities Managers".

2. 24-Hour Continuous Monitoring

a. Continual monitoring of Gaseous Indoor Air Quality Parameters shall include: carbon dioxide (CO2), carbon monoxide (CO) and two classes of total volatile organic compounds (TVOC). This monitoring shall be performed utilizing air sampling installations and Infra-red Photo-acoustic Multi-Gas Analyzer configured for continuous, unattended operation for a 24-hour period. This survey shall include a visual inspection of the MER for parameters adversely affecting indoor quality. The inspection should be focused on mechanical hygiene and should follow the parameters dictated by EPA's guidelines such as the "Building Air Quality' A Guideline For Building Owners and Facilities Managers".

3.15 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Fan curves.

2. Manufacturers' test data.

3. Field test reports prepared by system and equipment installers.

4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.

2. Name and address of the TAB contractor.

3. Project name.

4. Project location.

5. Architect's name and address.

6. Engineer's name and address.

7. Contractor's name and address.

8. Report date.

9. Signature of TAB supervisor who certifies the report.

10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.

13. Data for terminal units, including manufacturer's name, type, size, and fittings.

14. Notes to explain why certain final data in the body of reports vary from indicated values.

15. Test conditions for fans performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters (at balanced condition).
    c. Cooling coil, wet- and dry-bulb conditions. coil condition (wet or dry)
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems. (Maximum and minimum).
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

i. ECM setting (maximum & minimum)

D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.

2. Duct, outlet, and inlet sizes.

3. Terminal units.

4. Balancing stations.

5. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches (mm), and bore.
i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches (mm), and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

3. Test Data (Design and Actual Values):

a. Total air flow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa). (External)
e. Fan suction static pressure inches wg (Pa)
f. If fan discharges into a plenum, discharge static pressure in plenum inches wg (Pa).
g. Filter static-pressure differential in inches wg (Pa).

h. Preheat-coil static-pressure differential in inches wg (Pa).
i. Cooling-coil static-pressure differential in inches wg (Pa).
j. Heating-coil static-pressure differential in inches wg (Pa).
k. Outdoor airflow in cfm (L/s).
l. Return airflow in cfm (L/s).
m. Outdoor-air damper position.
n. Return-air damper position.
o. ECM setting (maximum & minimum)
p. For systems with air flow stations, verify air flow readings vs balance condition at maximum and minimum
q. Fan discharge wet and dry-bulb temperatures in deg F (deg C).
r. Input voltage at each connection
s. Operating amperage at balanced condition for each phase leg

F. Apparatus-Coil Test Reports:

1. Coil Data: (Preheat, Cooling, Heating)

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch (mm) o.c.
f. Make and model number.
g. Face area in sq. ft. (sq. m).
h. Tube size in NPS (DN).
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Design and Actual Values):

a. Air flow rate in cfm (L/s).
b. Average face velocity in fpm (m/s).
c. Air pressure drop in inches wg (Pa).
d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
f. Mixed air, wet and dry-bulb temperatures in deg F (deg C).
g. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
h. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
i.
j. Entering-water temperature in deg F (deg C).
k. Leaving-water temperature in deg F (deg C).
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig (kPa).
n. Refrigerant suction temperature in deg F (deg C).

G. Electric-Coil Test Reports: For electric coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h (kW).
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Air flow rate in cfm (L/s).
i. Face area in sq. ft. (sq. m).
j. Minimum face velocity in fpm (m/s).

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h (kW).
b. Air flow rate in cfm (L/s).
c. Air velocity in fpm (m/s).
d. Entering-air temperature in deg F (deg C).
e. Leaving-air temperature in deg F (deg C).
f. Voltage at each connection.
g. Amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Manufacturer and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Fan arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches (mm), and bore.
i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches (mm), and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).

c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Suction static pressure in inches wg (Pa).
f. Variable frequency drive setting (maximum & minimum)
g. For systems with air flow stations, verify air flow readings vs balance condition at maximum and minimum
h. Input voltage at each connection
i. Operating amperage at balanced condition for each phase leg

I. Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F (deg C).
d. Duct static pressure in inches wg (Pa).
e. Duct size in inches (mm).
f. Duct area in sq. ft. (sq. m).
g. Indicated air flow rate in cfm (L/s).
h. Indicated velocity in fpm (m/s).
i. Actual air flow rate in cfm (L/s).
j. Actual average velocity in fpm (m/s).
k. Barometric pressure in psig (Pa).

J. Fan Coil (AC unit) (Constant VolumeReports

1. Unit Data

a. Air handling unit designation
b. Location
c. Terminal Box type (constant, variable, fan, etc.)
d. Model number and terminal box size
e. Terminal box inlet size in inches (mm)
f. Motor type (fan powered only)

2. Test Data (Design and Actual Values) (Supply, Return & Exhaust)

a. Terminal box inlet static pressure in inches (Pa)
b. Primary air flow at inlet cfm (L/s) (maximum & minimum)
c. Supply air flow at discharge cfm (L/s) (maximum & minimum)
d. Primary air flow temperature in deg F (deg C)
e. Supply air flow temperature (heating mode) in deg F (deg C)
f. Supply air flow temperature (cooling mode) (fan powered only) in deg F (deg C)

K. Room Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Room served.
e. Manufacturer.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft. (sq. m) and area factor.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm (L/s).
b. Air velocity in fpm (m/s).
c. Preliminary air flow rate as needed in cfm (L/s).
d. Preliminary velocity as needed in fpm (m/s).
e. Final air flow rate in cfm (L/s).
f. Final velocity in fpm (m/s).
g. Space temperature in deg F (deg C).

L. System-Coil Reports: For heat coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil size in inches (mm)
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
a. Entering-air temperature in deg F (deg C).
b. Leaving-air temperature in deg F (deg C).
c. Entering air temperature in deg F (deg C)
d. Leaving air temperature in deg F (deg C)
e. Space temperature in deg F (deg C)

M. Incremental Unit Reports (Fan Coil Units, etc.) Reports

1. Unit Data

a. Unit identification
b. Locations
c. Room or Area Served
d. Manufacturer
e. Model number

2. Test Data (Design and Actual Valves)

    a. Air flow rate in cfm (L/s) (ducted units only)
    b. Entering air temperature in deg F (deg C)
    c. Leaving air temperature in deg F (deg C)
    d. Space temperature in deg F (deg C)
    e. Flowmeter type

N. Instrument Calibration Reports:

1. Report Data:

    a. Instrument type and make.
    b. Serial number.
    c. Application.
    d. Dates of use.
    e. Dates of calibration.

3.16 VERIFICATION OF CONTROL OPERATION

A. General: Perform the checks outlined in the following for all air system controls:

1. Thermostats and humidistats - Verify calibration and operation of all thermostats and humidistats. Any Deficiencies shall be reported for correction. Recheck after correction. Record thermostat set point and output signal, space temperature.

2. Damper Operation - Verify operation and position for all dampers. Any Deficiencies shall be reported for correction. Recheck after correction.

3. Other Controls - Simulate control operations with control contractor in accordance with design requirements and manufacturer's recommendations. Any deficiencies shall be reported for correction. Recheck after correction.

3.17 DUCT LEAKAGE TESTS (IF NOT DONE BY HVAC CONTRACTOR.)

A. Testing and Balancing Contractor shall provide duct leakage tests on the system as specified below. See Section 23 13 16 titled "Metal Ducts" Part 3 sub-paragraph titled "Duct Schedule" for duct leakage requirements

B. Testing and Balancing Contractor shall meet with HVAC Contractor and coordinate the schedule for duct leakage testing. Testing and Balancing Contractor shall outline to the HVAC Contractor the assistance, equipment, duct openings etc. he will require from the HVAC Contractor in order to complete the leakage tests.

C. Leakage Tests

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.

2. Test the following systems:

   a. All ducts (supply, return, exhaust etc.) Pressure Class +/- 2" W G. or less before insulation is applied shall be pressure tested at scheduled external static pressure and joints for all mains, risers and branches shall be check for leakage and repair if necessary. Noisy and whistling leaks shall be repaired and the system shall then be retested
   b. Supply Ducts with a Pressure Class Higher Than 2-Inch wg (500 Pa): Test representative duct sections, selected by Architect from sections installed, totaling no less than 100 percent of total installed duct area for each designated pressure class.
   c. Return Ducts with a Pressure Class Higher Than 2-Inch wg (500 Pa): Test representative duct sections, selected by Architect from sections installed, totaling no less than 100 percent of total installed duct area for each designated pressure class.
   d. Exhaust Ducts with a Pressure Class Higher Than 2-Inch wg (500 Pa): Test representative duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
   e. Outdoor Air Ducts with a Pressure Class Higher Than 2-Inch wg (500 Pa): Test representative duct sections, totaling no less than 100 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

4. Test for leaks before applying external insulation.

5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.

6. Give ten days' advance notice for testing.

3.18 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.

2. Check the following for each system:

   a. Measure airflow of at least 15 percent of air outlets.
   b. Measure water flow of at least 10 percent of terminals.
   c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
   d. Verify that balancing devices are marked with final balance position.
   e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Commissioning Authority.

2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.

3. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.19 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93

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SECTION 23 07 13 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
7. Outdoor, concealed supply and return.
8. Outdoor, exposed supply and return.
9. Outdoor exposed exhaust ductwork

B. Related Sections:

1. Section 230716 "HVAC Equipment Insulation."
2. Section 230719 "HVAC Piping Insulation."
3. Section 233113 "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. LEED Submittals:
1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Environmental Chambers.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.

3. Detail application of field-applied jackets.

4. Detail application at linkages of control devices.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Sheet Form Insulation Materials: 12-inches (300 mm) square.

2. Sheet Jacket Materials: 12-inches (300 mm) square.

3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23, Section Titled "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule article for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation (Faced) (Type D-1):

1. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II with factory-applied FSK jacket

2. Insulation Characteristics

a. Thermal Conductivity (ASTM 518): 0.29 BTU*inch per Hr*FT2*°F (Labeled Thickness)

b. Thermal Conductivity (ASTM 518): 0.27 BTU*inch per Hr*FT2*°F (Compressed Thickness)

c. Compressed Thickness: 75% of Labeled Thickness

d. Density: 0.75 Lbs per Ft3

e. Maximum Flame Spread: 25

f. Maximum Smoke Spread: 50

g. Maximum Operating Temperature Index (Faced) (ASTM C411): 250°F

h. Maximum Operating Temperature Index (Unfaced) (ASTM C411): 350°F

i. Fungi Resistance (ASTM 1338): No promoting or breeding of fungi

3. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.

b. Johns Manville; Microlite.

c. Knauf Insulation; Friendly Feel Duct Wrap.

d. Manson Insulation Inc.; Alley Wrap.

e. Owens Corning; SOFTR All-Service Duct Wrap.

G. Mineral-Fiber Board Insulation (Faced) (Type D-2)

1. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2. Insulation Characteristics

a. Thermal Conductivity (ASTM 518): 0.22 BTU*inch per Hr*FT2*°F

b. Density: 4.25 Lbs per Ft3

c. Maximum Flame Spread: 25

d. Maximum Smoke Spread: 50

e. Maximum Operating Temperature Index (Faced)

(i) Faced Side; 150°F

(ii) Unfaced Side; 450°F

f. Maximum Operating Temperature Index: 450°F

g. Fungi Resistance (ASTM 1338): No promoting or breeding of fungi

3. Products: Subject to compliance with requirements, provide one of the following:

a. Certain Teed Corp; Centrpro

b. Johns Manville; 800 spin-glas

c. Knauf Insulation; Insulation Board.

H. Mineral-Fiber Blanket Insulation (Unfaced) (Type D-3)

1. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II.

2. Insulation Characteristics

a. Thermal Conductivity (ASTM 518): 0.29 BTU*inch per Hr*FT2*°F (Labeled Thickness)

b. Thermal Conductivity (ASTM 518): 0.27 BTU*inch per Hr*FT2*°F (Compressed Thickness)

c. Compressed Thickness: 75% of Labeled Thickness

d. Density: 0.75 Lbs per Ft3

e. Maximum Flame Spread: 25

f. Maximum Smoke Spread: 50

g. Maximum Operating Temperature Index (Unfaced) (ASTM C411): 350°F

h. Fungi Resistance (ASTM 1338): No promoting or breeding of fungi.

3. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.

b. Johns Manville; Microlite.

c. Knauf Insulation; Friendly Free Duct Wrap

d. Manson Insulation Inc.; Alley Wrap.

e. Owens Corning; SOFTR All-Service Duct Wrap.

4. Exposed Ducts: Provide a factory-applied vinyl jacket on ducts. For exposed ducts in public areas, cover staples or speed clips with a pressure sensitive tape compatible with jacket to ensure neat appearance

I. Mineral-Fiber Board Insulation (Unfaced) (Type D-4)

1. Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB.

2. Insulation Characteristics

a. Thermal Conductivity (ASTM 518): 0.22 BTU*inch per Hr*FT2*°F

b. Density: 4.25 Lbs per Ft3

c. Maximum Flame Spread: 25

d. Maximum Smoke Spread: 50

e. Maximum Operating Temperature Index 450°F

f. Fungi Resistance (ASTM 1338): No promoting or breeding of fungi

3. Products: Subject to compliance with requirements, provide one of the following:

a. Certain Teed Corp; CentraPro

b. Johns Manville; 800 Spin-glas.

c. Knauf Insulation; Insulation Board

J. Mineral-Fiber, Pipe and Tank Insulation (Type D-5)

1. Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ or FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; CrimpWrap.

b. Johns Manville; MicroFlex.

c. Knauf Insulation; Pipe and Tank Insulation.

d. Manson Insulation Inc.; AK Flex.

e. Owens Corning; Fiberglas Pipe and Tank Insulation.

K. Flexible Elastomeric Insulation (Type D-7):

1. Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

2. Insulation Characteristics

a. Thermal Conductivity; 0.245 Btu*inch per Hr*Sq Ft*°F per ASTM C177/C518

b. Surface Burning Characteristics (Maximum Insulation Thickness 2 Inches) per ASTM E84

(i) Flame Spread; 25 Maximum

(ii) Smoke Developed; 50 Maximum

c. Surface Temperature (Continuous); -297°F to 300°F per ASTM C411

d. Water Vapor Permeability; 0.03 Perm per ASTM E96

e. Fungi/Resistance; No Growth per ASTM C1338/ UL 181

3. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aerocel.

b. Armacell LLC; AP Armaflex.

c. K-Flex USA; Insul-Sheet, K-Flex Gray Duct Liner, and K-FLEX LS

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aeroseal.

b. Armacell LLC; Armaflex 520 Adhesive.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.Eagle Bridges - Marathon Industries; 225.

b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.

b. Eagle Bridges - Marathon Industries; 225.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Foster Brand, Specialty Construction Brands, Inc., (30-80/30-90).

   b. Vimasco Corporation; (749).

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).

4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., (Encacel).

   b. Eagle Bridges - Marathon Industries; (570).

   c. Foster Brand, Specialty Construction Brands, Inc., (60-95/60-96).

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.

3. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).

4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.

5. Color: White.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands (CP-50AHV2)

   b. Foster Brand, Specialty Construction Brands (30-36)

   c. Vimasco Corp. (713 &714)

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.

4. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).

5. Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., (CP-76).

b. Foster Brand, Specialty Construction Brands, Inc., (95-44).

c. Mon-Eco Industries, Inc.; (44-05)

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).

5. Color: Aluminum.

6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. ASJ Flashing Sealants, and Vinyl Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).

5. Color: White.

6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm) for covering ducts.

1. Products: Subject to compliance with requirements, provide the following:

a. Childers Brand, Specialty Construction Brands, Inc., (Chil-Glas No. 5).

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for ducts.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; (Mast-A-Fab).

b. Vimasco Corporation; Elastafab (894).

2.8 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

1. Products: Subject to compliance with requirements, provide the following:

    a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.9 FIELD-APPLIED JACKETS

A. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc.; (Metal Jacketing Systems).

    b. ITW Insulation Systems; (Aluminum and Stainless Steel Jacketing).

    c. RPR Products, Inc.; (Insul-Mate).

2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

    a. Sheet and roll stock ready for shop or field sizing.

    b. Finish and thickness are indicated in field-applied jacket schedules.

    c. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, polysurlyn heat laminated to aluminum jacket

    d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, polysurlyn heat laminated to aluminum jacket

    e. Install per manufacturer’s recommendations

    f. For outdoor installations, all longitudinal and circumferential joints shall be made water tight

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.

    a. Sheet and roll stock ready for shop or field sizing Factory cut and rolled to size.

    b. Material, finish, and thickness are indicated in field-applied jacket schedules.

    c. Moisture Barrier for Indoor Applications 3-mil- (0.075-mm-) thick, polysurlyn heat laminated to aluminum jacket.

    d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, polysurlyn heat laminated to aluminum jacket.

    e. Install per manufacturer’s recommendations

    f. For outdoor installations, all longitudinal and circumferential joints shall be made water tight

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; (428 AWF ASJ).

b. Avery Dennison Corporation, (Fasson 0836).

c. Compac Corporation; (104 and 105).

2. Width: 3 inches.

3. Thickness: 10.8 mils.

4. Adhesion: 45 ounces inch in width.

5. Elongation: 2 percent.

6. Tensile Strength: 55 lbf/inch in width.

7. Service temperature -40°F to 300°F.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 491 AWF FSK.

b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.

c. Compac Corporation; 110 and 111.

d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches

3. Thickness: 9.0 mils

4. Adhesion: 45 ounces inch in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.

7. Service temperature -40°F to 250°F.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ABI, Ideal Tape Division; (488 AWF).

    b. Avery Dennison Corporation, Specialty Tapes Division; (Fasson 0800).

    c. Compac Corporation; (120).

    d. Venture Tape; (3520 CW).

2. Width: 2 inches.

3. Thickness: 3.6 mils.

4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.

5. Elongation: 4 percent.

6. Tensile Strength: 21 lbf/inch in width.

2.11 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. ITW Insulation Systems; Gerrard Strapping and Seals.

    b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.

3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.

4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- (3.5-mm-) diameter shank, length to suit depth of insulation indicated.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        (i) AGM Industries, Inc.; CWP-1.

(ii) GEMCO; CD.

(iii) Midwest Fasteners, Inc.; CD.

(iv) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

(i) AGM Industries, Inc.; CHP-1.

(ii) GEMCO; Cupped Head Weld Pin.

(iii) Midwest Fasteners, Inc.; Cupped Head.

(iv) Nelson Stud Welding; CHP.

3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel, aluminum or stainless-steel compatible with pine material sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

(i) AGM Industries, Inc.; RC-150.

(ii) GEMCO; R-150.

(iii) Midwest Fasteners, Inc.; WA-150.

(iv) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal ½ or 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel or 16 gauge copper clad pine.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. C & F Wire.

2.12 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.

B. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316.

2.13 WEATHERPROOFING FINISHES FOR OUTDOOR DUCTWORK (SUPPLY, RETURN & EXHAUST

A. Outdoor Rectangular Duct Work and Irregular Surfaces:

1. Ductwork and irregular surfaces shall be insulated as specified in Part 3 of this section and provided with a weatherproof finish as described herein.

2. The surfaces shall be weather protected with two coats of Insulcoustic VI-AC Mastic, I-C 551, or Benjamin Foster GPM Mastic with open weave glass cloth membrane imbedded between the coats. The total thickness of the coating shall be a minimum of 1/8". Roof ducts require polyisocyanurate board with EPDM cover.

B. Outdoor ductwork (supply, return and exhaust) that is not insulated shall be provided with a weatherproof finish as described in subparagraphs “A” above.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.

a. Apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Before applying insulation to ducts or plenums, sheet metal duct shall be clean and dry.

2. Check all ducts and plenums to verify that all seams and joints of ducts are tightly sealed

3. For ducts and plenums with air supply temperatures above 70°F, install insulations as follows:

a. Apply adhesive to all surfaces of duct or plenum per recommendation of insulation manufacturer

b. For horizontal ducts over 24 inches in width, install on bottom of duct capacitor-discharge-weld pins, impale insulation over weld pin and install speed clips to hold insulation. Cut excess portion of pins above speed clips.

c. For vertical ducts, install on all four sides of duct capacitor-discharge-weld pins, impale insulation over weld pin and install speed clips to hold insulation. Cut excess portion of pins above speed clips.

d. For plenums, install on sides and bottom of plenum capacitor-discharge-weld pins, impale insulation over weld pin and install speed clips to hold insulation. Cut excess portion of pins above speed clips.

e. For exposed ducts and plenums, butt all joints

f. For concealed ducts, overlap all longitudinal and circumferential joints of insulation 2 inches.

g. For concealed ducts, secure insulation to ducts with 16 gauge copper clad wire 12 inches on center.

h. Exposed ducts shall be provided with a vinyl jacket. Secure insulation with 2" longitudinal lap and ½ or ¾ inch outward-clinching staples 6 inches on center. Butt circumferential joints. Tape circumferential ducts with tape compatible with jacket

i. Maximum compressibility 25% of scheduled thickness. Do not over compress insulation.

4. For ducts and plenums with air supply temperatures below 70°F, install insulations with a continuous vapor barrier as follows:

a. Note that insulation (with vapor barrier) shall be continuous across all duct joints, hot water reheat coil pipe bends (insulated end caps), diffusers, etc. so as to provide a continuous, fully insulated with uninterrupted vapor barrier from the fan discharge to the diffusers.

b. Apply adhesive to all surfaces of duct or plenum per recommendation of insulation manufacturer

c. For horizontal ducts over 24 inches in width, install on bottom of duct capacitor-discharge-weld pins, impale insulation over weld pin and install speed clips to hold insulation. Cut excess portion of pins above speed clips.

d. For vertical ducts, install on all four sides of duct capacitor-discharge-weld pins, impale insulation over weld pin and install speed clips to hold insulation. Cut excess portion of pins above speed clips. Cover exposed pins and washers with pressure-sensitive tape matching insulation facing.

e. For plenums, install on sides and bottom of plenum capacitor-discharge-weld pins, impale insulation over weld pin and install speed clips to hold insulation. Cut excess portion of pins above speed clips.

f. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Butt adjacent section of insulation at joints tightly and secure lap with ½ or ¾ inch outward clinching staples 6 inches on center. Install pressure sensitive tape matching insulation facing circumferential joints, longitudinal seams and protrusions.

g. Maximum compressibility 25% of scheduled thickness. Do not over compress insulation.

h. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct.

B. Board Insulation Installation on Ducts and Plenums:

1. Before applying insulation to ducts or plenums, sheet metal duct shall be clean and dry.

2. Check all ducts and plenums to verify that all seams and joints of ducts are tightly sealed

3. For ducts and plenums with air supply temperatures above 70°F, install insulations as follows:

a. Install capacitor-discharge-weld pins to top, bottom and both sides of horizontal ducts and all four sides of vertical duct.

b. For ducts smaller than 18 inches, install a minimum of two rows of weld pins, 16 inches on center and a maximum of 3 inches from insulation edge

c. Install additional as required to hold insulation tight to cross bracing.

d. Install impale insulation over weld pins, install speed washers and cut excess portion of pin above speed clip.

e. Fill longitudinal seams, circumferential joints and voids in insulation with a cement compatible insulation material.

f. Exposed ducts shall be provided with a vinyl jacket, create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Butt adjacent section of insulation at joints tightly and secure lap with ½ or ¾ inch outward clinching staples 6 inches on center

4. For ducts and plenums with air supply temperatures below 70°F, install insulations with a continuous vapor barrier as follows:

a. Note that insulation (with vapor barrier) shall be continuous across all duct joints, hot water reheat coil pipe bends (insulated end caps), diffusers, etc. so as to provide a continuous, fully insulated with uninterrupted vapor barrier from the fan discharge to the diffusers.

b. Install capacitor-discharge-weld pins to top, bottom and both sides of horizontal ducts and all four sides of vertical duct.

c. For ducts smaller than 18 inches, install a minimum of two rows of weld pins, 16 inches on center and a maximum of 3 inches from insulation edge

d. Install additional as required to hold insulation tight to cross bracing.

e. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment.

f. Butt adjacent section of insulation at joints tightly.

g. Install impale insulation over weld pins, install speed washers and cut excess portion of pin above speed clip.

h. Fill longitudinal seams, circumferential joints and voids in insulation with a cement compatible insulation material.

i. Secure lap with ½ or ¾ inch outward clinching staples 6 inches on center.

j. Install pressure sensitive tape matching insulation facing circumferential joints, longitudinal seams and protrusions.

k. Cover exposed pins and washers with pressure-sensitive tape matching insulation facing.

l. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.

2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.

3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.

2. Install lap or joint strips with same material as jacket.

3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.

5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.

2. Indoor, exposed supply and outdoor air.

3. Indoor, concealed return located in unconditioned space.

4. Indoor, exposed return located in unconditioned space.

5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.

6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

7. Outdoor, concealed supply and return.

8. Outdoor, exposed supply and return.

9. Outdoor exposed exhaust ductwork

10. Indoor smoke control ductwork

B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.

2. Factory-insulated flexible ducts.

3. Factory-insulated plenums and casings.

4. Flexible connectors.

5. Vibration-control devices.

6. Factory-insulated access panels and doors.

3.9 DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation Schedule Notes

1. Ducts and casing that are acoustically lined (lining specified in another Section of Division 23) do not required exterior insulation except where the duct is located outdoors. For acoustically lined ducts and casing located outdoors, the thickness of insulation shall be as scheduled for duct located outdoors.

2. Weatherprotect outdoor supply, return and exhaust air ducts as specified in a previous paragraph in Part 2 of this specification.

3. Weatherprotect vertical conditioned air supply, return and exhaust air risers as located in a weather tight Architectural Enclosure.

4. Ducts and casing that are acoustically lined (lining specified in another Section of Division 23) do not required exterior insulation. If the “R” value for the duct lining is less than the scheduled “R,” either increase the thickness of the lining or provide external insulation so that the total “R” (lining plus insulation is at least equal to scheduled “R”

B. Duct Insulation Schedule

DUCT INSULATION SCHEDULE			
SYSTEM	INSULATION TYPE	INSULATION THICKNESS INCHES	REMARKS
Conditioned supply air (70°F or less) duct from fan discharge to device that reduces air pressure (concealed and exposed in mechanical rooms above 8 -0") (See Note 4)	Type D-1	2	Insulation "R" value (minimum) = 6 but not less than 2 inches
Conditioned supply air (70°F or less) duct from fan discharge to device that reduces air pressure (exposed in mechanical rooms below 8' -0") (See Note 4)	Type D-2	1 1/2	Insulation "R" value (minimum) = 6 but not less than 1 1/2 inches
Conditioned supply air duct (70°F or less) from fan discharge or device that reduces pressure to air distribution device including air distribution device plenums (See Note 4)	Type D-1	2	Insulation "R" value (minimum) = 6 but not less than 2 inches
Return Air Ducts (See Note 4)	Type D-1	1 1/2	Insulation "R" value (minimum) = 6 but not less than 1 1/2 inches. Return air ducts in ceiling plenums do not require insulation except return ducts directly below roof shall be insulated.

DUCT INSULATION SCHEDULE			
SYSTEM	INSULATION TYPE	INSULATION THICKNESS INCHES	REMARKS
Plenums (supply, return and exhaust)	Type D-2	1 1/2	Insulation "R" value (minimum) = 6 but not less than 1 1/2 inches
Low pressure supply air (70°F or greater) from fan discharge to air distribution devices including air distribution device plenum (See Note 4)	Type D-3 for all concealed ducts and exposed ducts in mechanical rooms above 8'-0"; Type D-4 for exposed ducts in mechanical room below 8'-0"	2 inch Type D-3; 1 1/2 inch Type D-4;	Insulation "R" value = 6 but not less than 2 inches Type D-3; 1 1/2 Type D-4. Exposed ducts shall be provided with a factory applied vinyl jacket
Low pressure supply air (70°F or less) from fan discharge to air distribution devices including air distribution device plenum (See Note 4)	Type D-1 for all concealed ducts and exposed ducts in mechanical rooms above 8'-0"; Type D-2 for exposed ducts in mechanical room below 8'-0"	2 inch Type D-1; 1 1/2 inch Type D-2;	Insulation "R" value (minimum) = 6 but not less than 2 inches Type D-1; 1 1/2 Type D-2.
Low pressure supply air (70°F or less) from device that reduces pressure to air distribution devices including air distribution device plenum	Type D-1	2	Insulation "R" value (minimum)e = 6 but not less than 2 inches

DUCT INSULATION SCHEDULE			
SYSTEM	INSULATION TYPE	INSULATION THICKNESS INCHES	REMARKS
Ducts and plenums containing all a percentage of outside air from plenum to inlet of air handling unit or fan	Type D-1 for all concealed ducts and exposed ducts in mechanical rooms above 8'-0"; Type D-2 for exposed ducts in mechanical room below 8'-0"	2 inch Type D-1; and Type D-2;	
Conditioned supply air (greater or less than 70°F) located outdoors from fan discharge to 3 feet below roof or inside wall; (See Note 1 & Note 2)	Type D-1	2 1/2	Insulation "R" value (minimum)= 8 but not less than 2 1/2 inches
Return air duct located outdoors from 3 feet below roof or inside wall to equipment; (See Note 1 & Note 2)	Type D-1	2 1/2	Insulation "R" value (minimum) = 8 but not less than 2 1/2 inches
Exhaust Ducts from Automatic Control Damper to exhaust plenum	Type D-2	2	
All outdoor exhaust ductwork from 3 feet below roof or inside wall to equipment	Type D-1	2	
All outdoor exhaust ductwork from 3 feet below roof or inside wall to Energy Recovery Unit	Type D-1	2 ½	

3.10 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Ducts and Plenums, Exposed.

1. Aluminum; Smooth surface 0.32 inch (0.81 mm) thick for round ducts or pipes 24 inches and diameter and smaller; 0.40 inch (1.0 mm) thick for round ducts and pipes 25 inches and larger

2. Painted Aluminum; Smooth surface 0.32 inch (0.81 mm) thick for round ducts or pipes 24 inches and diameter and smaller; 0.40 inch (1.0 mm) thick for round ducts and pipes 25 inches and larger

3. Stainless Steel; Type 304, smooth 2B finish surface 0.20 inch (0.51 mm) thick for round ducts or pipes 24 inches and diameter and smaller; 0.24 inch (0.51mm) thick for round ducts and pipes 25 inches and larger.

END OF SECTION 23 07 13

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SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping.

2. Refrigerant suction and hot-gas piping, indoors and outdoors.

B. Related Sections:

1. Division 23 Section "HVAC Equipment Insulation."

2. Division 23 Section "Duct Insulation."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.

2. Laboratory Test Reports for Credit EQ 4: For adhesives and sealants, documentation indicating that product complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

3. Detail removable insulation at piping specialties.

4. Detail application of field-applied jackets.

5. Detail application at linkages of control devices.

D. Qualification Data: For qualified Installer.

E. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

D. Mineral-Fiber, Preformed Pipe Insulation: (TYPE P-1)

1. Products: Subject to compliance with requirements. Provide one of the following:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" paragraph.

3. Insulation Characteristics

a. Thermal Conductivity; 0.23 Btu*inch per Hr*Sq Ft*°F @ 75°F
b. Operating Temperature Range; 0°F to 850°F
c. Surface Burning Characteristics (ASTM E84, UL-723, NFPA 255
    1) Maximum Flame Spread: 25
    2) Maximum Smoke Spread: 50
d. Shrinkage (per ASTM C 356); None
e. Fungi and Bacteria Resistance; No promoting or breeding of fungi or bacteria

4. Insulation to be provided with a longitudinal self-sealing lap (SSL). Self sealing lap (SSL) adhesive closure shall provide a positive mechanical and vapor longitudinal seam.

5. Circumferential joints shall be sealed with self-sealing butt strip. Self sealing lap (SSL) adhesive closure shall provide a positive mechanical and vapor circumferential joint.

E. Flexible Elastomeric Insulation (Type P-3)

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

2. Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

3. Insulation Characteristics

a. Thermal Conductivity; 0.257 Btu*inch per Hr*Sq Ft*°F @ 75°F per ASTM C-177
b. Service Temperature Range; -295°F to 300°F per ASTM C-411
c. Water Vapor Permeability; 0.10 perm per ASTM C-355
d. Moisture Absorption (weight %); 0.2 % per ASTM C 209
e. Surface Burning Characteristics (ASTM E84)(for pipe sizes 2 inch and less
1) Maximum Flame Spread: 25
2) Maximum Smoke Spread: 50
f. Density; 4/6 Lbs/ Ft3 per ASTM D1667

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Ramco Insulation, Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Ramco Insulation, Inc.; Thermokote V.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

1. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., 85-60/85-70.

d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Use adhesive that complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Foster Brand, Specialty Construction Brands, Inc., 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).

4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., Encacel.
b. Eagle Bridges - Marathon Industries; 570.
c. Foster Brand, Specialty Construction Brands, Inc., 60-95/60-96.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.

3. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).

4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.

5. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., CP-10.
b. Eagle Bridges - Marathon Industries; 550.
c. Foster Brand, Specialty Construction Brands, Inc., 46-50.
d. Mon-Eco Industries, Inc.; 55-50.
e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).

4. Solids Content: 60 percent by volume and 66 percent by weight.

5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., CP-50 AHV2.
   b. Foster Brand, Specialty Construction Brands, Inc., 30-36.
   c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.

4. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).

5. Color: White.

2.6 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Pittsburgh Corning Corporation; Pittseal 444.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Permanently flexible, elastomeric sealant.

4. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).

5. Color: White or gray.

6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Use sealants that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
    d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).

5. Color: Aluminum.

6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Use sealants that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

C. ASJ Flashing Sealants, and Vinyl Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).

5. Color: White.

6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Use sealants that comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

4. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perms) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas Number 10.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for pipe.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
b. Vimasco Corporation; Elastafab 894.

2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.10 FIELD-APPLIED JACKETS

A. Metal Jacket:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
    b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
    c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

    a. Factory cut and rolled to size.
    b. Finish and thickness are indicated in field-applied jacket schedules.
    c. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, polysurlyn heat laminated to aluminum jacket
    d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, polysurlyn heat laminated to aluminum jacket
    e. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.

    a. Factory cut and rolled to size.
    b. Material, finish, and thickness are indicated in field-applied jacket schedules.
    c. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, polysurlyn heat laminated to stainless steel jacket
    d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, polysurlyn heat laminated to stainless steel jacket
    e. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.

5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ABI, Ideal Tape Division; 428 AWF ASJ.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
c. Compac Corporation; 104 and 105.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches (75 mm).

3. Thickness: 11.5 mils (0.29 mm).

4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.

7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches (75 mm).

3. Thickness: 6.5 mils (0.16 mm).

4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.

7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.12 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.

3. Stainless Steel: ½ inch wide x 0.020 inch thick Type 304 with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

C. Wire: 0.080-inch (2.0-mm) nickel-copper alloy.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. C & F Wire.

2.13 WEATHERPROOFING FINISHES FOR OUTDOOR INSULATION

A. Outdoor Piping

1. Piping shall be insulated as specified in Part 3 of this Section and provided with a weatherproof finish as described herein.

2. Finish with a metal jacket which has a factory applied moisture barrier. For all applications where it is available, the jacketing shall be factory attached to the insulation and installed per manufacturer's recommendation.

3. Where field applied jacketing must be used, it shall be applied with 2" overlap facing down from the weather and shall be secured with bands compatible with band material and seals applied on 12" centers with bands applied directly over butt overlaps. As an alternate, the jacketing may be applied with Pli-Grip Rivets. Where jacketing is cut out or abuts an uninsulated surface, the joint shall be sealed with Insul-Coustic Sure Joint 405, or BF 30-45 Foam seal.

4. Fittings and valves shall be insulated and finished with mitered sections of the insulation with factory attached metal jackets installed per manufacturer's recommendation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation. Electric pipe heat tracing shall be furnished and installed by the Contractor responsible for the work of Division 26.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Systems operating below 70°F are defined as "below ambient" systems and require continuous vapor barrier protection. Systems operating above 70°F are defined a "above ambient" system.

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

E. Install insulation with longitudinal seams at top and bottom of horizontal runs.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

H. Keep insulation materials dry during application and finishing.

I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

J. Install insulation with least number of joints practical.

K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

M. Installation of Type P-1 insulation on “below ambient” concealed and exposed piping system as follows:

1. Insulation for both exposed and concealed piping systems includes and ASJ jacket with pressure sensitive self- sealing lap

2. Longitudinal seams and circumferential joints for systems requiring Type P-1 insulation shall be provided with a continuous vapor barrier for both longitudinal seams and circumferential joints.

3. Butt longitudinal seam of performed pipe insulation tightly

4. Seal self-sealing lap at longitudinal seam in accordance with manufacturer’s recommended procedure. Seal along longitudinal seam shall be continuous to maintain vapor barrier.

5. Butt circumferential joints of adjacent section of insulation tightly

6. Seal circumferential joints with a minimum 3 inch wide pressure self-sealing tape in accordance with manufacturer’s recommendations.. Seal along both sides of circumferential joint shall be continuous to maintain vapor barrier

7. For both longitudinal seams and circumferential joints, verify with Insulation Manufacturer whether vapor barrier mastic is required in addition to self-sealing lap and tape is necessary to maintain vapor barrier.

8. Where multiple layers of insulation are required, the 1st layer of insulation does not require a ASJ jacket. Staggered both longitudinal seams and circumferential joints.

N. Installation of Type P-3 insulation as follows:

1. Slip insulation over pipe prior to being connected.

2. If insulation cannot be installed prior to being connected to system, slit insulation longitudinally and snap insulation over pipe.

3. Install adhesive compatible with insulation along the entire length of longitudinal slit in accordance with manufacturer's recommendations to secure insulation and maintain vapor barrier.

4. For circumferential joints, install adhesive to adjacent sections of pipe insulation in accordance with manufacturer's recommendations and butt tightly to maintain vapor barrier.

O. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

P. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

Q. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

R. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.

2. Testing agency labels and stamps.

3. Nameplates and data plates.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

C. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

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

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

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

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

D. Install removable insulation covers at locations where service of equipment required. Installation shall conform to the following:

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

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

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

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

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

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

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

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

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

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

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

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

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

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.

2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.

3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with bands compatible with metal jacket material 12 inches (300 mm) o.c. and at end joints.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range.

B. Pipe Insulation Schedule

PIPE INSULATION SCHEDULE			
PIPING SYSTEM	INSULATION TYPE	INSULATION THICKNESS (INCHES)	REMARKS
Condensate drains from A.C. units, fan coil units, heat pump units, other equipment with cooling coils and miscellaneous drain piping subject to sweating (All Pipe Sizes)	P-1 or P3	1	For horizontal piping at or in ceilings.
Refrigerant Suction Piping	P-1 or P-3	1 1/2	

3.10 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

1. Aluminum; Smooth surface 0.32 inch (0.81 mm) thick for round pipes 24 inches and diameter and smaller; 0.40 inch (1.0 mm) thick for pipes 26 inches and larger

2. Painted Aluminum; Smooth surface 0.32 inch (0.81 mm) thick for pipes 24 inches and diameter and smaller; 0.40 inch (1.0 mm) thick for pipes 26 inches and larger

3. Stainless Steel; Type 304, smooth 2B finish surface 0.20 inch (0.51 mm) thick for pipes 24 inches and diameter and smaller; 0.24 inch (0.51mm) thick for pipes 26 inches and larger

END OF SECTION 23 07 19
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SECTION 23 07 20 - ACOUSTICAL DUCT LINING AND DUCT WRAP

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Ductwork acoustical lining.

B. Ductwork sound barrier acoustical wrap.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 23 05 00, Common Work Results for HVAC.

C. Section 23 05 50, Basic Mechanical Materials and Methods.

D. This section is a part of each Division 23.

1.3 REFERENCES

A. ANSI/ASTM C553 - Mineral Fiber Blanket and Felt Insulation.

B. ANSI/ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.

C. ASTM E84 - Surface Burning Characteristics of Building Materials.

D. NFPA 255 - Surface Burning Characteristics of Building Materials.

E. UL 723 - Surface Burning Characteristics of Building Materials.

F. UL 181 – For Erosion Test

1.4 QUALITY ASSURANCE

A. Applicator: Company specializing in ductwork acoustic lining application with three years minimum experience.

1.5 SUBMITTALS

A. Submit product data under provisions of Section 01 30 00.

B. Include product description, list of materials and thickness for each service, and locations.

C. Submit manufacturer's installation instructions under provisions of Section 01 30 00.

D. Approval of the above-named products is contingent upon samples to be submitted to our office. Also, after approval, contractor shall furnish to the job site a section of the material applied to a 24 x 24 section of sheetmetal. This will be maintained at the job site for quality control.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acoustical Duct Lining Materials: The following vendors will be reviewed for approval providing they meet all the performance requirements of the specifications.

a. CertainTeed Corporation; Insulation Group (Ultralite).

b. Johns Manville (Linacoustic).

c. Owens Corning (Aeroflex).

B. Sound Barrier Acoustical Wrapping: The following vendors will be reviewed for approval providing they meet all the performance requirements of the specifications.

1. EAR - TUFCOTE barrier absorber composite;

2. Sound Coat - Soundmat PB embossed;

3. Sound Seal - Barrier/fiberglass Type BSC-25;

4. Kinetics - Barrier composite KBC - 100QQ

5. Substitutions are not acceptable.

2.2 MATERIALS DUCT LINING

A. Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

B. Acoustical Liner R-Values:

1. Where located within a building envelope in unconditioned spaces, acoustic lining shall be 1½ lb. per cubic foot minimum density, with minimum thickness 1½ inches or equivalent R-6 value, unless specified to be greater.

2. Where located outside of building envelope, acoustic lining shall have thermal resistance value of R-8, unless specified to be greater. Coordinate liner thickness with liner manufacturer.

C. Lining shall have a composite fire and smoke hazard rating (UL 723) not exceeding:

Flame Spread: 25

Smoke Developed: 50

D. Asbestos shall not be used in the manufacture of lining products.

E. Include a foil face or barrier against shedding.

F. Solvent or Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

G. All portion of ducts designated to receive duct liner (acoustical) shall

1. Provide complete coverage of sheet metal for designated lengths.

2. Transverse joints shall be neatly butted and there shall not be interruptions or gaps.

3. Black coated surface of duct liner shall face the air stream.

4. Duct liner shall be adhered to sheet metal with 100% coverage of adhesive.

5. All exposed leading edges and all transverse joints shall be coated with adhesive.

6. Duct liner shall be additional secured with mechanical fasteners in accordance with SMACNA HVAC Duct Standards – Metal and Flexible except that gripnails or equivalent shall not be allowed.

7. Duct liner shall be cut to assure overlapped and compressed longitudinal corner joints.

8. Fasteners shall start with in 3” of upstream transverse edges of the liner and 3” from longitudinal joints and spaced as per SMACNA.

H. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) 0.135-inch-(3.5-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.

2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

2.3 SOUND BARRIER WRAPPING

A. Ductwork shall be fully wrapped with acoustical barrier/absorber lagging material, as specified herein, as shown on the drawings, or as required.

B. Acoustical barrier/absorber lagging material construction must meet the following requirements:

1. Material to consist of one barrier layer sandwiched between either two sound absorbing layers, or one sound absorbing layer and one decoupling layer.

2. Minimum barrier layer density of 1 lb/ft2

3. Minimum absorber layer thickness of 1" (each layer).

4. Minimum decoupling layer thickness of 1" (each layer).

5. Minimum absorbing layer NRC rating of 0.75.

6. Minimum composite material STC rating of STC-24.

C. Acoustical barrier/absorber lagging material shall meet all applicable flammability, chemical resistance, temperature resistance, and wear requirements.

D. Ducts shall be fully wrapped with lagging material on all sides, leaving no gaps, holes, or open areas exposed. Lagging material may be fixed and sealed with tape meeting all applicable flammability and resistance requirements, or another suitable method as provided or recommended by the lagging manufacturer.

E. Acoustical barrier/absorber lagging submittal drawings shall include the following information:

1. Decoupling and Sound Absorbing layer(s) material and thickness.

2. Barrier layer material, thickness, and density.

3. Overall material construction STC rating and MRC rating.

F. Asbestos shall not be used in the manufacture of wrapping products.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean surfaces before applying adhesives.

3.2 INSTALLATION

A. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 100 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

2. Apply adhesive to transverse edges of liner. Adhesive is not required for transverse edges of liner facing upstream that receives metal nosing.

3. Butt transverse joints without gaps, and coat joint with adhesive.

4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.

6. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.

7. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

a. Fan discharges.

b. Intervals of lined duct preceding unlined duct.

8. Terminate inner ducts with metal nosing 4 inches upstream and downstream of fire-damper sleeves.

9. Where a duct liner required for thermal insulation or condensation control has been interrupted a duct covering of equal thermal performance shall be installed. Duct covering shall overlap liner 3” on each side.

B. This contractor shall make all necessary repairs to the lining where improperly applied, or damaged.

C. Duct sizes shown on drawings shall be considered as clear inside dimensions.

D. A perforated inner metal liner consisting of 22 ga. galv. steel with 3/32" dia. holes on 3/16" or 1/4" centers or the equivalent aluminum shall be installed in every one of the following conditions. (Fastening for metal liners shall only be by welded stud. Where duct cross section exceeds 48" the top section shall be fastened with twice the number of clips.)

1. Where shown on drawings.

2. Where called for elsewhere in these documents.

3. Where the duct can be walked on, metal liners shall be used on bottom portions.

E. The leading edge of acoustical duct liner (facing into the air flow) of each non abutting section such as the first section facing into the fan or the first section after a sound trap.

F. All portions of duct designated to receive acoustical duct liner shall be completely covered with acoustical duct liner. Transverse joints shall be neatly butted and there shall be no interruptions or gaps. The black coated surface of the acoustical duct liner shall face the air stream. The acoustical duct liner shall be adhered to the sheet metal with 100% coverage of adhesive and all exposed leading edges and all transverse joints coated with adhesive. Adhesive shall conform to Adhesive and Sealant Council Standards for Adhesives for duct liner; ASC-C-7001C-1972. The acoustical duct liner shall be additionally secured with mechanical fasteners (Mechanical fasteners shall conform to Mechanical Fastener Standard MF-1-l971, available from Sheet Metal and Air Conditioning Contractors National Association), except that gripnails or the equivalent shall not be allowed. Acoustical duct liner shall be cut to assure overlapped and compressed longitudinal corner joints. Fasteners shall start within 3" of the upstream transverse edges of the liner and 3" from the longitudinal joints and shall be spaced as recommended by SMACNA.

3.3 SCHEDULE

A. The following items shall be acoustically lined. Where distances of lining are indicated, the intent is that all ductwork <u>in any direction</u> be acoustically lined. Supply ductwork shall not have acoustical lining, unless otherwise noted in plan.

DUCT LINER (ACOUSTICAL) SCHEDULE				
DUCT SYSTEM	DUCT LINER THICKNESS (INCHES)	DUCT LINER LENGTH (FEET) (MINIMUM)	DUCT LINER MATERIAL	REMARKS
Upstream from Return Fan (including) Plenum	1½	15	Fibrous-Glass Duct Liner	
Upstream from Exhaust Fan (including) Plenum	1	15	Fibrous-Glass Duct Liner	
Downstream from Exhaust Fans	1	15	Fibrous-Glass Duct Liner	If discharge of the exhaust fan runs through occupied spaces.
Single offset Transfer Ducts	1	Full Length	Fibrous-Glass Duct Liner	
Double offset Transfer Ducts	1	Full Length	Fibrous-Glass Duct Liner	
Where shown drawings	1½	As Detailed	Fibrous-Glass Duct Liner	

B. The following items may be wrapped with a flexible sound barrier acoustical material:

1. Downstream of supply fans for a distance of 25 feet.

2. Upstream of return fans for a distance of 25 feet.

END OF SECTION 23 07 20

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SECTION 23 08 00 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

1. Section 01 91 13 "General Commissioning Requirements" for general commissioning process requirements.

C. Intent:

1. The intended result of the Mechanical commissioning process is to assure the Owner and the Architect that the HVAC systems, control systems, plumbing systems and fire protection systems are installed and operate in accordance with Owner's Project Requirements, Basis of Design, Contract Drawings and specifications prior to acceptance of the building.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. The following responsibilities are in addition to those specified in Division 01 Section "General Commissioning Requirements."

B. Perform commissioning tests at the direction of the CxA.

C. Attend construction phase controls coordination meeting.

D. Attend testing, adjusting, and balancing review and coordination meeting.

E. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

F. Provide information requested by the CxA for final commissioning documentation.

G. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

H. A heat load is usually required to properly commission the HVAC systems. A sufficient heat load shall be provided, by the General Contractor in the form of load banks and/or heaters in the conditioned space for as long as is required to complete start up and the commissioning procedure.

1.6 CxA'S RESPONSIBILITIES

A. Provide Project-specific pre-functional checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Commissioning Record and Systems Manual.

1.7 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan/report:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.

2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.

3. Process and schedule for completing pre-functional checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.

4. Certified Pipe Cleaning and Flushing Report: CxA shall certify that pipe cleaning, flushing, hydrostatic testing, and chemical treating have been completed.

5. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.

6. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.

7. Test and inspection reports and certificates.

8. Completed pre-functional checklists.

9. Corrective action documents.

10. Updates to issue log.

11. Certified testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that the plumbing systems, subsystems, and equipment have been completed, calibrated and started, are operating according to the OPR, BoD, and Contract Documents; and that Certificates of Readiness are signed and submitted.

D. Certify that fire protection systems, subsystems, and equipment have been completed, calibrated, and started; are operating according to the OPR, BoD, and Contract Documents; and that Certificates of Readiness are signed and submitted.

E. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

F. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, failover, and alarm conditions).

G. Inspect and verify the position of each device and interlock identified on checklists.

H. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

I. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA, for the required test period. Instrumentation shall monitor and record full range of operating conditions and shall allow for calculation of total capacity of system for each mode of operation. For individual room cooling tests, provide temporary heaters to impose a cooling load indicated in BoD. Operational modes include the following:

1. Occupied and unoccupied.
2. Warm up and cool down.
3. Economizer cycle.
4. Emergency power supply.
5. Life-safety and safety systems.
6. Fire safety.
7. Temporary upset of system operation.
8. Partial occupancy conditions.
9. Special cycles including staging to full load and all failure modes.

J. Verify equipment interface with monitoring and control system and TAB criteria; include the following:

1. Supply and return flow rates constant volume systems in each operational mode.
2. Operation of terminal units in both heating and cooling cycles.
3. Minimum outdoor-air intake in each operational mode and at minimum and maximum airflows.
4. Building pressurization.
5. Total exhaust airflow and total outdoor-air intake.
6. Operation of indoor-air-quality monitoring systems.

K. Verify proper responses of monitoring and control system controllers and sensors to include the following:

1. For each controller or sensor, record the indicated monitoring and control system reading and the test instrument reading. If initial test indicates that the test reading is outside of the control range of the installed device, check calibration of the installed device and adjust as required. Retest malfunctioning devices and record results on pre-functional checklist, test procedure or data sheet.
2. Report deficiencies and prepare an issues log entry.

L. Verify that HVAC, controls, plumbing and fire protection equipment field quality-control testing has been completed and approved. CxA shall direct, witness, and document field quality-control tests, inspections, and startup specified in individual Division 23 Sections.

M. Pre-functional checklists have been completed by all subcontractors, and verified and compiled by the CxA.

N. There will be no concurrent "commissioning limiting" construction performed during testing.

O. There will be no computer or telecommunications hardware on-line during the building testing.

P. All equipment start-up technicians must be available throughout the commissioning process as needed.

1. Equipment technicians will perform testing as required by commissioning specifications to demonstrate compliance.

Q. All required load banks and cabling (as specified in the commissioning procedures) must be available.

1. Must be of the correct load bank size (kW), voltage, discharge type, and must have cable of sufficient size and length.

R. All systems must be 100% complete – as if they were to be turned over to the owner by the start of testing. The space that houses the equipment and that the equipment serves must be at design conditions (temperature and humidity) with permanent lighting available. The spaces shall be broom clean so that equipment can be operated safely with all extra construction materials removed so that maintenance access can be evaluated.

3.2 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.

1. The CxA will notify testing and balancing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.

2. The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.

3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.

4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

D. Ductwork Air Leakage Testing:

1. Architect will identify, for HVAC Contractor and CxA, portions of duct systems to have ductwork air leakage testing. Ductwork air leakage testing shall be performed according to Division 23 Section "Metal Ducts," and shall be witnessed by the CxA.

2. On approval of preliminary ductwork air leakage testing report, the CxA shall coordinate verification testing of ductwork air leakage testing. Verification testing shall include random retests of portions of duct section tests, reported in preliminary ductwork air leakage testing report. The HVAC Contractor shall perform tests using the same instrumentation (by model and serial number) as for original testing; the CxA shall witness verification testing.

3.3 PRE-FUNCTIONAL CHECKLISTS

A. Execute pre-functional checklists for each system, subsystem and piece of equipment.

B. Pre-functional checklists shall be attached to the equipment as it is delivered to the site and shall remain with the equipment throughout installation, checkout and start-up. System Pre-functional checklists will remain in control of the applicable trade foreman.

C. Pre-functional checklists shall be filled out on a daily basis and verified by the appropriate supervisor daily. The supervisor is responsible for accuracy and completeness.

D. During construction inspections the CxA will spot check and verify Pre-functional checklists for accuracy and completeness.

E. The Contractor shall maintain a log of Pre-functional checklists and shall report completion of each checklist.

F. The CxA shall collect all Pre-functional checklists before testing begins.

3.4 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC&R Contractor, testing and balancing Contractor, and HVAC&R Instrumentation and Control Contractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.5 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 23 09 00 "Instrumentation and Control for HVAC" and Section 23 09 93 "Sequence and Operations for HVAC Controls." Assist the CxA with preparation of testing plans.

B. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in HVAC piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.

2. Description of equipment for flushing operations.

3. Minimum flushing water velocity.

4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

C. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of refrigerant compressors and condensers, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

D. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

1. Plumbing System Testing: Plumbing Contractor shall assist the CxA in preparing a testing plan to verify performance of domestic water heating, plumbing fixture, sanitary and storm drainage, sewage ejection, pumping and other plumbing systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. Fire Protection System Testing: Fire Protection Contractor shall assist the CxA in preparing a testing plan to verify performance of wet sprinkler, dry sprinkler, pre-action sprinkler, clean agent suppression, fire pump and other fire protection systems. Include detection and notification devices provided under Division 21, 22 26 sections. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

F. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation.

G. Deferred Testing:

1. If tests cannot be completed because of a deficiency outside the scope of the Mechanical system, the deficiency shall be documented and reported to Owner. Deficiencies shall be resolved and corrected by appropriate parties and test rescheduled.

2. If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented and additional tests scheduled.

H. Testing Reports:

1. Reports shall include measured data, data sheets, and a comprehensive summary describing the operation of systems at the time of testing.

2. Include data sheets for each controller to verify proper operation of the control system, the system it serves, the service it provides, and its location. For each controller, provide space for recording its readout, the reading at the controller's sensor(s), plus comments. Provide space for testing personnel to sign off on each data sheet.

3. Prepare a preliminary test report. Deficiencies will be evaluated by Architect to determine corrective action. Deficiencies shall be corrected and test repeated.

4. If it is determined that the system is constructed according to the Contract Documents, Owner will decide whether modifications required to bring the performance of the system to the OPR and BoD documents shall be implemented or if tests will be accepted as submitted. If corrective Work is performed, Owner will decide if tests shall be repeated and a revised report submitted.

3.6 CONTRACTOR COMMISSIONING PROCEDURES

A. The Contractor and all relevant sub-contractors shall, in addition to being responsive to the procedures cited for execution by the CxA, perform as follows to achieve satisfactory HVAC system, control system, plumbing system and fire protection system commissioning. The Contractor shall:

1. Demonstrate the performance of each piece of equipment to the CxA and Owner's representative after completion of construction. Schedule the TAB, HVAC controls, energy management and other sub-trade representatives as may apply to demonstrate the performance of the equipment and systems.

2. At a minimum, the performance and operation demonstrations of the following equipment and/or systems will be required:

a. Incremental equipment (fan coil units, cabinet heaters, unit ventilators, etc.); approximately 20-percent of units installed.
b. Major duct flow and pressure checks, air terminals. The TAB trade representative shall identify all places where temperature, pressure and/or velocity readings were taken in major duct systems; and performances shall be demonstrated on 20-percent of locations. Up to 5-percent of air terminals shall have performance demonstrated.
c. AHU performance; all air handling units and up to 30-percent of exhaust fans.
d. Fan and motor performance; all air handling units and up to 30-percent of exhaust fans.
e. HVAC controls system; complete control sequence of central plant equipment and air handling units, and up to 20-percent of incremental equipment.
f. Plumbing fixture performance.
g. Drainage system performance.
h. Domestic water heater performance.

3. In addition to the foregoing, the Contractor shall repeat any other measurement contained in the TAB report where required by the CxA for verification or diagnostic purposes. Should any verification test reveal that the equipment is not performing as specified or control operation is not acceptable, the Owner will be entitled to one re-inspection of any failed item at no additional cost from the CxA, so long as the retesting is scheduled within the originally scheduled testing period. Should the verification test determine that the equipment is still not performing as specified or control operation is not acceptable on the second inspection, or if any retesting requires a return visit to the site by the CxA, the time and expenses of the CxA to make further verification shall be considered as additional cost to the Owner. The total sum of such costs shall be deducted from the final payment to the Contractor.

END OF SECTION 23 08 00

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SECTION 23 09 00 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control for terminal heating and cooling equipment not supplied with factory-wired controls.

B. Related Sections of Division 23 including the following

1. Section titled "Sequence of Operation for HVAC Controls"

2. Section titled "Control Point List"

3. Applicable Sections of Division 23 for equipment provided with factory mounted controls that interface with the Building Management System (BMS) provided as part of this Section.

4. Applicable Sections of Division 21, 22 & 26 for equipment provided with factory mounted controls that interface with the Building Management System (BMS) provided as part of this Section.

C. General Work Description

1. Building Management System (BMS) controls contractor shall provide:

a. A fully integrated Building Management System (BMS), UL-listed, incorporating Direct Digital Control (DDC) for energy management, equipment monitoring, and HVAC control.

b. Electronic sensors.

c. All actuators for dampers shall be electric. All sensors shall be electric/electronic.

d. All line voltage and low voltage wiring, conduit, panels, and accessories for a complete operational system. All final electrical connections to each standalone DDC Controller.

e. BMS Contractor shall be responsible for all electrical work associated with the BMS and as shown in the contract documents. The BMS contractor shall be responsible for all electrical work associated with any BMS interface to any other systems including but not limited to HVAC and plumbing systems.

f. The BMS contractor shall furnish all wells for water monitoring devices, flow switches, and alarms.

g. A complete operational system including all work as defined in the entire set of drawings and specifications, including but not limited to associated specifications for mechanical and electrical work, all contract drawings, BMS Point List, and remote function schedule.

h. The BMS system as a whole shall have the capability to be easily expanded through the addition of point modules and/or controllers. No equipment shall be installed which cannot, as installed, accommodate an upgrade the entire system by at least 25%. A 25% system upgrade shall include 25% more points (of each type) either via point modules or controllers and 25% more memory capacity for future connections.

i. Provide appropriate labor jurisdiction to mount, wire and pipe airflow measuring stations in the field. Provide manpower as required to meet project schedule.

1.3 TECHNICAL PROPOSALS

A. Technical proposals shall be prepared in accordance with these specifications. Four (4) copies of the proposal shall be submitted with the bid. Proposals that are unbound, loose, loose in a file folder, stapled, stapled in a manila file folder, etc., will not be acceptable. The technical proposal shall include the following data/information as a minimum. The order of listing here is not intended to indicate, nor should it be construed to indicate, the relative importance of the data/information:

1. Information on organizational capability to handle this project (management, personnel, manufacturing, single source responsibility, etc.). Provide an organizational chart of the local factory branch office indicating the project team and each person's role in the project. Provide a resume for each project team member and all management personnel.

2. A comprehensive bar chart project schedule indicating submission of shop drawings, equipment delivery, installation, start-up commissioning, training, milestones, and all critical path tasks.

3. A project specific on-site and off-site training program which demonstrates specification compliance.

4. BMS Configuration as Proposed:

B. Modularity.

C. Provisions against obsolescence due to technological advancement.

D. Detailed description of all operating, command, application and energy management software provided for this project.

E. Provide a riser drawing of the system architecture. The drawing shall indicate the model number, location and service of each primary control panel, secondary control panel, PC workstation and all other network hardware.

F. A complete description of all interface and/or integration packages.

G. Provide a complete submittal of all hardware, software, sensors and end devices (damper operators, airflow stations, etc.).

H. Description of manual override operation and BMS monitoring of manual override operation and BMS monitoring of manual override for each type control point in system.

I. A list of references (include Owner contact name and phone number) for five (5) projects completed by the BMS contractor within the last five years of similar size, schedule and complexity.

J. A line by line BMS specifications concordance summary. The summary shall be in table form and indicate each article and paragraph by number and whether the proposed BMS contractor 'Does Comply' or 'Does Not Comply' with the paragraph. If the item does not comply, the bidder shall provide a written explanation.

K. A signed certificate stating the Contractor 'has read the performance and functional requirements, understands them, and the technical proposal will comply with all parts of the specification' or a signed line by line specification concordance statement. Certificate or statement shall be signed by a person having the authority to guarantee the statement.

1.4 ABBREVIATIONS

A. AACP - Advanced Application Control Panel

B. AI - Analog Input

C. ANSI - American National Standards Institute

D. AO - Analog Output

E. ASCII - American Standard Code for Information Interchange

F. ASCP - Application Specific Controller

G. AWG - American Wire Gauge

H. AWS - Advanced Work Station

I. BMS - Building Management System

J. CAV - Constant Air Volume

K. CPU - Central Processing Unit

L. CRT - Cathode Ray Tube

M. DAC - Digital to Analog Converter

N. DDC - Direct Digital Control

O. DI - Digital Input

P. DO - Digital Output

Q. EEPROM Electronically Erasable Programmable Read Only Memory

R. EMI - Electromagnetic Interference

S. FAS - Fire Alarm Detection and Annunciation System

T. HOA - Hand-Off-Auto

U. IEEE - Institute of Electrical and Electronics Engineers

V. I/O - Input/Output

W. LAN - Local Area Network

X. LCD - Liquid Crystal Display

Y. LED - Light Emitting Diode

Z. NC - Normally Closed

AA. NO - Normally Open

BB. OWS - Operator Workstation

CC. OAT - Outdoor Air Temperature

DD. PC - Personal Computer

EE. POT - Portable Operator's Terminal

FF. PCOW - Personal Computer Operator Workstation

GG. RAM - Random Access Memory

HH. RFI - Radio Frequency Interference

II. RH - Relative Humidity

JJ. ROM - Read Only Memory

KK. RTD - Resistance Temperature Detector

LL. TCP/IP - Transmission Control Protocol/Internet Protocol

MM. UPS - Uninterruptible Power Supply

NN. VAC - Volts, Alternating Current

OO. VAV - Variable Air Volume

PP. VDC - Volts, Direct Current

QQ. WAN - Wide Area Network

1.5 SYSTEM DESCRIPTION

A. General Product Description

1. The building management system (BMS) shall integrate multiple building functions including equipment supervision and control, alarm management, energy management and historical data collection.

2. The building management system shall consist of the following:

a. Distributed control systems complete with all software and hardware functions shall be provided and installed. System shall be completely based on ANSI/ASHRAE Standard 135, BACnet. This system is to control all mechanical equipment, including all unitary equipment such as AC units, etc. and all air handlersand any other listed equipment using native BACnet-compliant components. Non-BACnet-compliant or proprietary equipment or systems (including gateways) shall not be acceptable and are specifically prohibited.

b. The Building Management System (BMS) application program shall be written to communicate specifically utilizing BACnet protocols. Software functions delivered on this project shall include password protection, scheduling (including optimum start), alarming, logging of historical data, full graphics including animation, after-hours billing program, demand limiting, full suite of field engineering tools including graphical programming and applications. Systems using operating systems other than that described above are strictly prohibited. All software required to program application specific controllers and all field level devices and controllers will be left with the owner. All software passwords required to program and make future changes to the system will also become the property of the owner. All software required to make any program changes anywhere in the system along with scheduling, and trending applications will be left with the owner. All software passwords required to program and make future changes to schedules, trends and related program changes will also become the property of the owner. All software required for all field engineering tools including graphical programming and applications will be left with the owner. All software passwords required to program and make future changes to field engineering tools including graphical programming and applications will be left with the owner.

c. Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. All energy management software and firmware shall be resident in field hardware and shall not be dependent on the operator's terminal. Operator's terminal software is to be used for access to field-based energy management functions only. Provide zone-by-zone direct digital logic control of space temperature, scheduling, runtime accumulation, equipment alarm reporting, and override timers for after-hours usage.

d. All application controllers for every air handler, all central plant equipment, and any other piece of controlled equipment shall be fully programmable. Application controllers shall be mounted next to controlled equipment and communicate with building controller via BACnet LAN.

e. Room sensors shall be provided with digital readout that allows the user to view room temperature, view outside air temperature, adjust the room set point within preset limits and set desired override time. User shall also be able to start and stop unit from the digital sensor. Include all necessary wiring and firmware such that room sensor includes field service mode. Field service mode shall allow technician to balance zones and access any parameter in zone controller.

1.6 SEQUENCE OF OPERATION

A. Refer to Division 23 09 10; Section Titled "Sequence of Operations for HVAC Controls" for sequence of operation.

1.7 ACTION SUBMITTALS

A. General

1. Indicate at the beginning of each submittal, all substitutions and deviations from requirements of Contract Documents.

B. Product Data

1. Technical bulletins and catalog data for all equipment and system components. Clearly identify, by use of symbol or tag number, the service of each item. All irrelevant information shall be marked out leaving only pertinent data.

C. Shop Drawings

1. Shop drawing submittals shall comply with Division 01 and other specified requirements and shall include sufficient data to indicate complete compliance with Contract Documents. Submission shall be in the form of drawings, brochures, bulletins, catalog data and/or narrative descriptions.

a. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, relays/switches, control panels, and operator interface equipment.

b. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

c. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

2. Submission shall include, but not be limited to:

   a. Symbol and abbreviation lists.

   b. System block diagram showing quantity and location of personal operator workstation(s), Primary Control Panels, Secondary Control Panels, and locations of power feeds to BMS and other major system components.

   c. Bill of materials of equipment indicating quantity, manufacturer, and model number.

   d. Schematic flow diagrams showing fans, coils, dampers, and control devices.

   e. Wiring Diagrams: Power, signal, and control wiring.

   f. Details of control panel faces, including controls, instruments, and labeling.

   g. Control Damper Schedule each damper provided under this section and the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, Actuator Type, Leakage Rate and Flow Characteristics.

   h. DDC System Hardware:

      (i) Wiring diagrams for control units with termination numbers.

      (ii) Schematic diagrams and floor plans for field sensors and control hardware.

      (iii) Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

   i. Power wiring diagrams and electrical requirements.

   j. Interfaces (software and hardware) with other equipment provided in other sections of specifications including but not limited to chiller control system.

   k. Narrative description of operation for each system, enumerating and describing the function of each component. Include alarm and emergency sequences, and equipment interlocks.

   l. Description of manual override operation for every input and output point.

   m. Complete input/output point schedule. Identify point function, type and location.

   n. Spare capacity provisions.

   o. Detailed bill of materials.

   p. Device mounting details. Include as a minimum:

(i) Sensing elements in ducts and casings.

q. Network architecture (ladder) diagrams including all nodes and interconnections

r. All information required for USGBC LEED Green Buildings Certification pre evaluation including applications and equipment impact on individual attainment of points. Where a specific device may assist in qualification for LEED points indicate and summarize contribution.

s. Details of all interfaces and connections to the work of other trades.

t. Other information as requested herein.

u. Complete full size drawings, 11" x 17" minimum.

3. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.

4. Controlled Systems:

a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.

b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.

c. Written description of sequence of operation including schematic diagram.

d. Points list.

D. Programming

1. Point identification code.

2. System advisory messages, printouts, logging formats.

3. Drawings of system graphics showing monitored points. (Include only if graphics are specified elsewhere in this specification).

4. Software flow-charts for applications and DDC programs.

5. Person machine interface program, including commands, alarm annunciation, logs and programming capabilities.

6. Description of system operation under failure conditions.

E. Samples

1. All wall, pipe and duct sensors.

2. All other devices mounted on finished surfaces.

3. Samples for Verification: For each color required, of each type of thermostat or sensor cover.

4. Damper, panel and sensor tags.

F. Quality Control Submittals

1. UL, FM, CSA listing compliance certificates.

2. Final calibration, commissioning and testing reports.

G. Time Requirements

1. Within thirty (30) days of award of contract manufacturer shall provide schedule of all submittals employing format as provided hereinafter and enumerating all drawings, samples and miscellaneous submittals by name, quantity, etc.

1.8 QUALITY ASSURANCE

A. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

B. All portions of the system must be of the same manufacturer and must be designed, furnished, installed, commissioned and serviced by manufacturer-approved, factory trained employees.

C. Single source responsibility of supplier shall be the complete installation and proper operation of the BMS and control system and shall include debugging and proper calibration of each component in the entire system.

D. Supplier shall have an in-place support facility within 50 miles of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment.

E. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

F. BMS shall comply with UL 916 PAZX and 864 UDTZ and be so listed at the time of bid.

G. All system components shall be fault-tolerant. System shall include:

1. Satisfactory operation without damage at 110% and 85% of rated voltage and at plus 3 Hertz variation in line frequency.

2. Static, transient and short-circuit protection on all inputs and outputs.

3. Protection for communication lines against incorrect wiring, static transients and induced magnetic interference.

4. Network-connected devices to be AC coupled or equivalent so that any single device failure will not disrupt or halt network communication.

5. All real time clocks and data file RAM to be battery-backed for a minimum 72 hours and include local and remote system low battery indication.

H. The BMS contractor shall be regularly engaged in the design installation and maintenance of BMS systems and shall meet the following qualifications.

1. A minimum of five (5) years of demonstrated technical expertise and experience in the design installation and maintenance of BMS systems similar in size and complexity to this project.

2. A minimum of five (5) years experience installing the control system of the manufacturer that is to be proposed.

3. Shall be a certified-to-install, direct representative of a control system manufacturer that has a minimum of ten (10) years experience producing control systems similar to that which is to be proposed.

4. A maintained service organization consisting of at least eight (8) competent servicemen, within 60 miles of the project site, for a period of not less than four (4) years.

5. The Bidder shall not be considered qualified to bid this project unless they can provide a list of 10 projects, similar in size and scope to this project, completed within the last five (5) years.

I. The system installer shall provide an experienced project manager for this work from beginning of control installation until final completion. The project manager responsible for direct supervision of the design, installation, start-up and commissioning of the BMS as well as attending of project meetings whenever directed by the owner, construction manager, and/or mechanical contractor. It shall not be acceptable to change the project manager after the project has begun and before final completion. If the BMS contractor wishes to change the project manager, the construction manager and/or Owner's representative must be notified immediately and both the new project manager and the previous project manager shall spend 5 consecutive business days together on-site performing a project management switch-over.

J. Comply with all current governing codes, ordinances, and regulations including UL, NFPA, the local Building Code, NEC, etc.

K. The manufacturer of the Building Management System (BMS) shall provide documentation supporting compliance with ISO-9002 (model for Quality Assurance in Production). The intent of this specification requirement is to ensure that the products and services that the manufacturer provides are delivered through a Quality System and Framework that will assure consistence quality through the project.

L. The system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability for any existing control system component including but not limited to Primary Control Panels, Secondary Control Panels, personal operator workstations, and portable operator's terminals, to be connected and directly communicate with any new BMS system equipment without bridges, routers or protocol converters.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.10 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 26 Section Titled "Lighting Controls" to achieve compatibility with equipment that interfaces with that system.

C. Coordinate equipment with Division 26 Section Titled "Fire Alarm" to achieve compatibility with equipment that interfaces with that system.

D. Coordinate supply of conditioned electrical circuits for control units and operator workstation.

E. Coordinate equipment with Division 26 Section Titled "Panelboards" to achieve compatibility with starter coils and annunciation devices.

1.11 EXTRA MATERIALS

A. Furnish extra materials described below to match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Replacement Materials: Provide one replacement component for each unique control device including as a minimum:

1. Panels:

a. DDC panel board components.

b. Relays.

c. Power supplies and transformers.

2. Field input devices:

a. Space and air temperature sensors.

b. Space and air humidity sensors.

c. Air differential pressure transmitters.

d. Static pressure transmitter.

e. Air differential switch.

f. Freezestat

g. Current switches.

3. Field output devices:

a. Actuators for dampers.

C. Maintenance Materials: Any unique or special tools that are required for proper operation, maintenance and repair as outlined in the system operation, maintenance and repair manuals shall be provided.

D. Provide a complete list of replacement and maintenance materials in the technical proposal.

1.12 RECORD DOCUMENTS

A. Owner's Manual General

1. Submit two (2) draft copies of owner's manuals for review. After review by authorized representative, the contractor shall incorporate review comments and shall submit four (4) interim final copies. Upon completion of project, acceptance of project by the owner, submit six (6) copies of final "as built" manuals and one (1) reproducible copy (3-mil sepia Mylar).

2. Update manuals with modifications made to system during guarantee period. Provide replacement pages or supplements in quantity stated above for "as built" manuals.

3. Assemble owner's manuals into multi-volume sets.

4. Protect each volume with a heavy-duty vinyl plastic binder. Volumes to have plastic printed dividers between major sections and have oversized binders to accommodate up to one inch thick set of additional information.

5. Each binder to be silk screened with project name and volume title on front cover and binder.

6. On the first page of each manual identify with project name, title, owner's name, engineer's name, contractor's name, address and service phone number, and person who prepared manual.

B. Provide an operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system. Include as a minimum:

1. Control flow diagrams for all building systems.

2. Sequence of operation for automatic and manual operating modes for all building systems. The sequences shall cross-reference the system point names.

3. Description of manual override operation of all control points in system.

4. BMS system manufacturer's complete operating manuals.

C. Provide a maintenance manual to serve as training and reference manual for all aspects of day-to-day maintenance and major system repairs. Include as a minimum:

1. Complete as-built installation drawings for each building system.

2. System Operator's manuals including all information required to maintain LEED Green Building certification.

3. Archive copy of all site specific databases and sequences.

4. Network diagrams.

5. Interfaces to all third party products and work by other trades.

6. Overall system electrical power supply scheme indicating source of electrical power for each system component. Indicate all battery backup provisions.

7. Overall system shielding and grounding scheme indicating all major components and ground paths.

8. Drawings showing installation details and locations of equipment.

9. Charts showing normal operating conditions at significant points such as electrical test points.

10. Routine preventive maintenance procedures, corrective diagnostics troubleshooting procedures, and calibration procedures.

11. Parts lists with manufacturer's catalog numbers and ordering information.

12. Lists of ordinary and special tools, operating materials supplies and test equipment recommended for operation and servicing.

13. Manufacturer's operating, set up, maintenance and catalog literature for each piece of equipment.

14. Maintenance and repair instructions.

15. Recommended spare parts.

16. Field test reports.

D. Provide a programming manual to serve as training and reference manual for all aspects of system programming. Include as a minimum include the following:

1. Complete programming manuals and reference guides.

2. Details of any special software packages and compilers supplied with system.

3. Information required for independent programming of system.

4. Point schedule including all points, real and pseudo.

5. Project specific software troubleshooting procedures.

E. Maintenance Data and Operating Instructions:

1. Maintenance and operating manuals in accordance with Section 01 00 00, General Requirements.

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

b. Contents: Prepare a Table of Contents for each volume, with each Product or system description identified, in three parts as follows:

(i) Part 1: Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractors, and major equipment suppliers.

(ii) Part 2: Operation and maintenance instructions arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:

(a) Significant design criteria.

(b) List of equipment.

(c) Parts list for each component.

(d) Operating instructions.

(e) Maintenance instructions for equipment and systems.

(iii) Part 3: Project documents and certificates, including the following:

(a) Shop drawings and product data.

(b) Certificates.

(c) Photocopies of warranties.

(d) Photocopies of bonds.

2. Contents, Each Volume

a. Table of Contents: Provide title of project; names, addresses, and telephone numbers of Architect/Engineer, Sub-consultants and contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.

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

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

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

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

f. Warranties.

g. Bonds.

3. Manual for Equipment and Systems

a. Each item of equipment and each system: Include description of unit or system and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.

b. Panelboard Circuit Directories: provide electrical service characteristics, controls, and communications.

c. Include color-coded wiring diagrams as installed.

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

e. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting, disassembly repair, and re-assembly instructions; and alignment, adjusting, balancing, and checking instructions.

f. Provide servicing and lubrication schedule for dampers and actuators and list of lubricants required.

g. Include manufacturers printed operation and maintenance instructions.

h. Include sequence of operation by BMS manufacturer.

i. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required.

j. Provide control diagrams by controls manufacturer as installed.

k. Provide BMS contractor's coordination drawings, with color coded control piping diagrams as installed.

l. Provide list of original manufacturers' spare parts, current prices, and recommended quantities to be maintained in storage.

m. Additional requirements as specified in individual Product specification sections.

n. Provide a listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.

4. Instruction of Designated Facility Personnel

a. Before final inspection, instruct Owner's designated personnel in operation, adjustment and maintenance of products, equipment, and systems, at agreed upon times.

b. For equipment requiring seasonal operation, perform instruction for other seasons within six months.

c. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

d. Prepare and insert additional data in Operation and Maintenance manual when need for such data becomes apparent during instruction.

5. After all final tests and adjustments have been completed, fully instruct the proper Owner's Representative in all details of operation for equipment installed. Supply qualified personnel to operate equipment for sufficient length of time to assure that Owner's Representative is properly qualified to take over operation and maintenance procedures. Supply qualified personnel to operate equipment for sufficient length of time as required to meet all governing authorities in operation and performance tests.

6. Furnish required number of manuals, in bound form containing data covering capacities, maintenance and operation of all equipment and apparatus. Operating instruction shall cover all phases of control and include the following:

a. Lubrication Schedule: Indicating type and frequency of lubrication required for dampers and actuators.

b. List of Spares: Recommended for normal service requirements.

c. Parts List: Identifying the various parts of the equipment for repair and replacement purposes.

d. Instruction Books may be standard booklets but shall be clearly marked to indicate applicable equipment.

e. Wiring Diagrams: Generalized diagrams are not acceptable, submittal shall be specifically prepared for this Project.

F. Display of Maintenance Instructions

1. One set of operating and maintenance instructions shall be neatly framed behind glass and hung adjacent to the equipment concerned.

G. Record Drawings

1. The BMS contractor shall provide a complete set of "as-built" or record drawings. The drawings shall be prepared and delivered to the architect in an acceptable AutoCAD format.

2. The drawings shall indicate:

a. All BMS work installed exactly in accordance with the original design.

b. All BMS work installed as a modification or addition to the original design.

c. The dimensional information necessary to delineate the exact location of all wiring runs that are so concealed as to be untraceable by inspection through the regular means of access established for inspection and maintenance. Where shop drawings have been prepared and approved, the "as-built" drawings shall be cross-referenced to the respective shop drawing.

d. All wiring routing locations must be shown.

3. As-built record drawings shall include the updating of all equipment schedule sheets.

4. The record drawings shall be reproducible as directed.

5. The BMS Contractor shall make arrangements with the Engineer to obtain design drawings on CD ROM disks in AutoCAD format for use as a basis for the "as-built" drawings. These documents remain the property of Cosentini Associates and shall not be used for any other purpose without expressed, written consent. The contractor shall assume all liabilities resulting from unauthorized use or modifications to the drawings.

6. Prior to developing any "as-built" drawings, the contractor shall coordinate with the Owner and the Architect Engineer the drawing layers, etc., of the CAD drawings.

7. "As-built" information shall be submitted as follows:

a. CAD drawing files on CD ROM disks in AutoCAD format. The version of AutoCAD to be utilized shall be the version in use by the Engineer at the time of the submission.

b. Two (2) sets of reproducible drawings.

c. Three (3) sets of blueprints.

8. The quantity of design drawings which are made available shall in no way be interpreted as setting a limit to the number of drawings necessary to show the required "as-built" information.

9. Progress prints of record drawings shall be submitted monthly during the construction period for Architect's approval.

10. This trade shall submit the "as-built" set for approval by the building department in a form acceptable to the department, when required by the jurisdiction.

11. The contractor shall provide files on disks in an ASCII format for all schedules, catalog information, installation instructions manuals (information) indexed by system and/or equipment.

12. All equipment and systems require proper identification and tagging, including a system description. This information must be coordinated with all design and shop drawings.

1.13 WARRANTY

A. The Contractor shall warranty the BMS to be free from defects in workmanship and material for a period of one (1) year from the date of acceptance by the Owner. During the warranty period. This contractor shall also provide all system software upgrades during the warranty period upon notice from the owner to Contractor, if the system is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the Owner at the cost of the Contractor.

B. The Contractor shall provide an on-line troubleshooting service during the warranty period. The on-line system shall allow the contractor or Owner's agent the ability to interrogate, troubleshoot and correct warranty defects remotely. This system shall be operational 24 hours a day, 365 days a year. If the local manufacturer's staff cannot resolve the problem, the corporate home office staff shall remotely connect to the system and troubleshoot the warranty defect.

C. The Contractor shall submit a written report within 3 days of all warranty defects, the action taken, and corrections made for each warranty call.

D. Extended Maintenance Contract (Alternates 1 & 2)

1. ALTERNATE 1: The BMS contractor shall provide, as part of the base bid price, a one-year preventative maintenance service contract covering all parts, materials, software, hardware, and all costs to provide software and hardware upgrades during the warranty period. The service contract shall include the following at a minimum:

a. Periodic maintenance (preventive and corrective maintenance). A minimum of one eight (8) hour on-site preventative maintenance days per month shall be provided;

b. Recommended spare parts.

c. Emergency service 24 hours a day, 7 days a week, 365 days per year. Response to emergency calls shall be made within 1 hour by phone and 4 hours on-site. Emergency hours shall not be deducted from preventive maintenance time.

d. 'Dial in Services' for troubleshooting via internet 24 hours a day, 7 days per week, 365 days per year. Maximum contractor response time shall be 2 hours.

2. ALTERNATE 2: The BMS contractor, as an alternate, shall provide a bid price to extend the maintenance service contract and the warranty, as specified herein, for four additional years following the warranty period.

a. The maintenance services to be provided in both the base bid and the alternate bid shall include, but are not limited to, the following: (refer to equipment schedules, and control drawings to point, equipment and systems count).

b. General

(i) All control items are to be maintained even if they were not installed under this contract.

(ii) The following are the minimum services required by the owner. If additional services to maintain the warranty are requested by the manufacturer or contained in the manufacturer's maintenance documentation, these services shall be included in both the base and alternate the bid.

(iii) All maintenance procedures must be as per the manufacturer's recommendation and not void any warranties.

(iv) All maintenance procedures must be performed on all systems and equipment based on good standard industry practices or from the Owner's direction.

(v) The BMS maintenance contractor must coordinate the PM program with any existing or new maintenance management system whether installed by this contractor or others.

(vi) The "Standard Terms and Conditions" for this contract will be provided by the facility.

c. Network

(i) Monthly

(a) The BMS contractor shall provide all software and electronic hardware upgrades as upgrades become available.

(b) Provide newly released software documentation updates, field support and technical bulletins.

(c) Provide operator support in identifying and resolving problems with software, operations or programming.

(ii) Quarterly

(a) Perform diagnostics on the network to analyze trunk traffic and optimize the trunk.

(b) Perform system file back up, field panel database and graphics database backup.

(c) Create or modify operator interface graphics as necessary to reflect changes in the system.

d. Primary, Secondary Control and Application Specific Terminal Equipment Controller (if applicable) Panels

(i) Monthly

(a) Verify regulated power assembly and battery voltages. Adjust if required.

(b) Ensure cabinet is at earth ground potential.

(c) Verify proper system electrical ground isolation.

(d) Inspect interconnecting cables and electrical connections.

(e) Via personal computer user interface, exercise controlled devices with manual command functions and verify proper response of connected field hardware. Check for alarms and overrides using note specific alarms and overrides.

(f) Inspect HOA switches for proper position. Coordinate activation of HOA switch test w/owner.

(g) Perform built-in, field panel diagnostic tests.

(h) Perform integrity test and system wide function test through random point checks, commands, selective disabling, and standard field cabinet reports.

(i) Note system points that are in override condition and review with building engineer.

(j) Note system points that are in alarm condition and review with building engineer.

(k) Review personal computer operator workstation(s) log book with engineer.

(ii) Annually

(a) Clean external surfaces of panel enclosure and associated primary and secondary controllers.

(b) Exercise point value display and run diagnostic self-test on primary and secondary control panels.

(c) Inspect interior surfaces and components of panel enclosure and associated primary and secondary control panels and clean if required. Ensure all mounted devices and plug-in components are securely in place.

(d) Evaluate binary and analog points for proper operation and reporting. At the personal computer operator workstation, make a general performance review of all points.

(e) Check individual critical points. Determine new or revised calibration coefficients as required. Make adjustments to connected field devices as required.

(f) Enter new revised calibration coefficients into software after completing critical point procedures for each primary or secondary control panel.

(g) Upgrade control panel firmware and software with new version as available.

(h) Review control loops for proper operation at a time when controlled conditions are stable and at setpoint. If necessary, verify or adjust tuning constraints (proportional/integral gains, etc.), setpoints, parameters, and/or reset schedules.

(i) Record any parameter values that are different than those shown on program listing.

(j) Label and date all field devices that have been changed or added.

e. All Control Dampers

(i) Semi-Annually

(a) Check damper linkage, setscrews, and blade adjustment for proper tightness. Lubricate as required.

(b) Operate dampers over full modulation range to ensure proper operation. Adjust as required. Repair/replace all defective components.

(c) Inspect condition of damper actuators. Operate actuators over full modulation range to ensure proper operation. Repair/replace all defective components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Electric, Electronic, and DDC Systems:

a. JCI

b. Alerton by ABM Systems

c. Honeywell Inc. by Factory Branch Office

d. Schneider Electric by Factory Branch Office

e. Siemens Inc. by Factory Branch Office

2.2 SYSTEM ARCHITECTURE

A. The Building Management System (BMS) is designed to support the comfort, safety, and productivity of the building's occupants and property. BMS shall integrate multiple building functions including equipment supervision and control, alarm management, energy management, information management, and historical data collection and archiving.

B. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, network controllers and operator devices, while re-using existing controls equipment.

C. In order to meet these requirements, the BMS must be capable of many methods of integration, at each tier of the network:

D. Owner Intranet Network

1. The BMS contractor shall be responsible for installation of primary and secondary LAN's required to support the complete BMS system. The Operator Interface Panel for the building shall be located as advised by the Project Manager.

E. BACnet Primary LAN

1. Primary LAN for the building automation system shall consist of a high speed network utilizing BACnet over Ethernet or BACnet/IP. The Primary LAN shall be used for communications between BACnet B-BC devices, B-AAC devices, and B-ASC devices.

F. BACnet Secondary LAN

1. A secondary LAN, separate from the Primary LAN shall be used for communications between B-ASC devices and the B-BC or B-AAC that provides BACnet router services for the device. The Secondary LAN shall utilize BACnet MS/TP for communications. The intent of the separate Primary LAN and Secondary LAN is to isolate traffic between B-BC's or B-AAC's and their associated B-ASC devices from the primary LAN.

2.3 OPERATOR INTERFACE

A. Advanced Work Station General

1. General structure of workstation interaction shall be a standard client/server relationship. Server shall be used to archive data and store system database. Thick and Web Clients shall access server for all archived data.

2. BACnet Conformance

a. Advanced Work Station shall be approved by the BTL as meeting the BACnet Advanced Work Station (AWS) requirements.

b. Please refer to Section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

c. Standard BACnet object types accessed by the workstation shall include as a minimum: Analog Value, Analog Input, Analog Output, Binary Value, Binary Input, Binary Output, Calendar, Device, Event Enrollment, File, Notification Class, Program, and Schedule object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

d. The AWS shall comply with Annex J of the BACnet specification for IP connections. Must support remote connection to server using a thick client application. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on wide area networks (WANs) and campus area networks (CANs). Workstation shall support Foreign Device Registration to allow temporary workstation connection to IP network.

B. Advanced Workstation Hardware

1. Provide One server. The server shall be located as per owner.

2. Advanced workstation shall be provided for command entry, information management, network alarm management and database management functions. All real-time control functions shall be resident in the DDC Controllers to facilitate greater fault tolerance and reliability.

3. The advanced workstation shall be an integrated node on the network and shall allow the operator to view the entire Building Management System network.

4. The monitoring and control functions of the Building Management System (BMS) shall be totally independent of the AWS so that if the Server is off-line (not operating), the Building Management System will continue to perform all of its monitoring and control functions.

5. The AWS Server shall consist (as a minimum) of but not be limited to:

a. Full tower Case or Rack Mount (Coordinate with owner)

b. 2 GHz dual-core processor or better

c. 64-bit OS

d. 8 GB RAM or better

e. 80GB hard disk or better

f. High-performance graphics adapter

g. Network interface card (100/1000 Mbps)

h. Keyboard, minimum 23” LCD color monitor, mouse, and DVD-R/W

i. Color Printer (Inkjet, Color Dye or Laser)

j. Un-interruptible Power supply

k. Windows 7, Windows 8, Windows 8.1, Windows Server 2012.

6. The above requirements shall be considered a minimum for the server. The Building Management System manufacturer shall review the above and if not sufficient for the requirements of the project, provide server with sufficient computing capability (including but not limited to processor speed/power, memory, local storage, etc.) to meet the system software minimum requirements, as well as with sufficient video display capabilities.

7. At the conclusion of project, contractor shall leave with owner a CD ROM that includes the complete software operation system and project graphics, set points, system parameters, etc. This backup shall allow the owner to completely restore the system in the case of a computer malfunction.

C. Advanced Workstation Software

1. Data Displays

a. Data displays shall render all data associated with project as called out on drawings and/or object type list supplied. Graphic files shall be created using digital, full color photographs of system installation, AutoCAD or Visio drawing files of field installation drawings and wiring diagrams from as-built drawings.

b. Data displays shall render all data using iconic graphic representations of all mechanical equipment. System shall be capable of displaying graphic file, text, and dynamic object data together on each display and shall include animation. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated without any action by the user.

c. Data display frame shall allow user to change all field-resident AWS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc., from any screen, no matter if that screen shows all text or a complete graphic display. This shall be done without any reference to object addresses or other numeric/mnemonic indications.

d. Analog objects shall be displayed with operator modifiable units. Analog input objects may also be displayed as individual graphic items on the display screen as an overlay to the system graphic.

e. All displays and programming shall be generated and customized by the local BMS supplier and installer. Systems requiring factory development of graphics or programming of DDC logic are specifically prohibited.

f. AWS shall be supplied with a library of standard graphics, which may be used unaltered or modified by the operator. AWS shall include a library of equipment graphic components to assemble custom graphics. Systems that do not allow customization or creation of new graphic objects by the operator (or with third-party software) shall not be allowed.

g. Data display frame shall include customizable and persistent tree navigation for building, equipment and system diagnostic centric display organization.

h. Each display may be protected from viewing unless operator credentials have the appropriate access level. An access level may be assigned to each display and system object. The menu label shall not appear on the graphic if the operator does not have the appropriate security level.

i. Data displays shall have the ability to link to content outside of the BMS system. Such content shall include but is not limited to: Launching external files in their native applications (for example, a Microsoft Word document) and launching a Web browser resolving to a specified Web address.

j. The AWS shall have the ability to support 20 concurrent web clients

k. Data displays shall support:

(i) Graphic items with custom geometry that offer both color gradient shading and variable opacity in scale to system variables and range set points.

(ii) Clear and custom geometry navigation buttons to provide intuitive navigation

(iii) Graphic files in jpg, png, and .gif file types

(iv) Viewing of 1024 system data points in a single screen

2. Password Protection

a. Provide security system that prevents unauthorized use unless operator is logged on. Access shall be limited to operator's assigned functions when user is logged on. This includes displays as outlined above.

b. AWS shall provide security for a minimum of 200 users. Each user shall have an individual User ID, User Name, and Password. Entries are alphanumeric characters only and are case sensitive (except for User ID). User ID shall be 0–8 characters, User Name shall be 0–29 characters, and Password shall be 4–8 characters long.

c. Each user shall be allowed individual assignment of only those control functions, menu items, and user specific system start display, as well restricted access to *discrete BACnet devices* to which that user requires access.

d. All passwords, user names, and access assignments shall be adjustable online at the operator's terminal.

e. Users shall also have a set access level, which defines access to displays and individual objects the user may control. System shall include 10 separate and distinct access levels for assignment to users.

f. System shall include an Auto Logout Feature that shall automatically logout user when there has been no keyboard or mouse activity for a set period of time. Time period shall be adjustable by system administrator. Auto Logout may be enabled and disabled by system administrator. Operator terminal shall display message on screen that user is logged out after Auto Logout occurs.

g. The system shall permit the assignment of an effective date range, as well as an effective time of day, that the User IDs are permitted to authenticate.

3. Operator Activity Log

a. Operator Activity Log that tracks all operator changes and activities shall be included with AWS. System shall track what is changed in the system, who performed this change, date and time of system activity, and value of the change before and after operator activity. Operator shall be able to display all activity, sort the changes by user and also by operation. Operator shall be able to print the Operator Activity log display.

b. Log shall be gathered and archived to hard drive on AWS as needed. Operator shall be able to export data for display and sorting in a spreadsheet.

4. Scheduling

a. AWS and Web Client shall show all information in easy-to-read daily format including calendar of this month and next. All schedules shall show actual ON/OFF times for day based on scheduling priority. Priority for scheduling shall be events, holidays and daily, with events being the highest.

b. Holiday and special event schedules shall display data in calendar format. Operator shall be able to schedule holidays and special events directly from these calendars.

c. Operator shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate access privileges.

d. AWS shall include a Schedule Wizard for set up of schedules. Wizard shall walk user through all steps necessary for schedule generation. Wizard shall have its own pull-down selection for startup or may be started by right-clicking on value displayed on graphic and then selecting Schedule.

e. Scheduling shall include optimum start based on outside air temperature, current heating/cooling set points, indoor temperature and history of previous starts. Each and every individual zone shall have optimum start time independently calculated based on all parameters listed. User shall input schedules to set time that occupied set point is to be attained. Optimum start feature shall calculate the startup time needed to match zone temperature to set point. User shall be able to set a limit for the maximum startup time allowed.

f. Schedule list shall show all schedules currently defined. This list shall include all standard, holiday and event schedules. In addition, user shall be able to select a list that shows all scheduled points and zones.

g. Display of all three schedules must show all ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show all points and zones affected. User shall be able to set time for one day and select all days of the week that shall be affected as a recurrence of that same schedule for that given day.

h. Any displayed data that is changeable by the operator may be selected using the right mouse button and the schedule shall then be selectable on the screen. Selection of the schedule using this method shall allow the viewing of the assigned schedule allow the point to be scheduled.

i. Schedule editor shall support Drag-n-drop events and holidays onto the schedule calendar

j. Schedule editor shall support Drag-n-drop events default to a 2hr period; which can then be adjusted by the user.

k. Schedule editor shall support Drag-n-drop holidays are defaulted for OFF all day and can be edited for multiple-day holidays.

l. Schedule editor shall support the View of affected zones when adding or editing timed events of a schedule.

5. Alarm Indication and Handling.

a. AWS shall provide visual, printed, and email means of alarm indication. Printout of alarms shall be sent to the assigned terminal and port. Alarm notification can be filtered based on the User ID's authorization level.

b. Web client shall display a persistent alarm state for the system regardless of the data view including points in alarm but not acknowledged, and points that have gone into alarm and returned to normal without being acknowledged.

c. Alarm History shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the AWS. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment, and identification of operator acknowledging alarm.

d. Alarm messages shall be in user-definable text (English or other specified language) and shall be delivered either to the operator's terminal, client or through remote communication using email (Authenticated SMTP supported).

e. AWS shall include an Alarm Wizard for set up of alarms. Wizard shall walk user through all steps necessary for alarm generation. Wizard shall have its own pull-down selection for startup or may be started by right-clicking on value displayed on graphic and then selecting alarm setup.

f. AWS shall support color-coded indication of current alarms as follows:

g. Red indicator shows number of active alarms that have not been acknowledged.

h. Yellow indicator shows number of alarms that are still active but have been acknowledged.

i. Blue indicator shows number of alarms that have returned to normal but have not been acknowledged.

j. Color-coded indicators, when selected by the user, navigate to a pre-filtered view of Alarm History.

k. Alarm history can be filtered by color-coded indicator states.

l. Alarm annunciation includes navigation link to a user selected display or URL.

m. User can silence audible annunciation for the current session.

n. User can disable auto-refresh of alarm annunciation for current session.

o. Any displayed data that is changeable by the operator may be selected using the right mouse button and the alarm shall then be selectable on the screen. Selection of the alarm using this method shall allow the viewing of the alarm history or allow the creation of a new alarm.

6. Trendlog Information

a. AWS shall periodically gather historically recorded data stored in the building controllers and store the information in the system database. Stored records shall be appended with new sample data, allowing records to be accumulated. Systems that write over stored records shall not be allowed unless limited file size is specified. System database shall be capable of storing up to 50 million records before needing to archive data. Samples may be viewed at the web client. Operator shall be able to view all trended records, both stored and archived. All trendlog records shall be displayed in standard engineering units.

b. AWS shall be capable of trending on an interval determined by a polling rate, or change-of-value.

c. AWS shall be able to change Trendlog setup information. This includes the information to be logged as well as the interval at which it is to be logged. All operations shall be password protected. Viewing may be accessed directly from any and all graphics on which a trended object is displayed.

d. AWS shall include a Trendlog Wizard for setup of logs. Wizard shall walk user through all necessary steps. Wizard shall have its own pull-down selection for startup, or may be started by right-clicking on value displayed on graphic, and then selecting Trendlogs from the displayed menu.

e. AWS shall be capable of using Microsoft SQL as the system database.

f. Any displayed data that is changeable by the operator may be selected using the right mouse button and the trendlog shall then be selectable on the screen. Selection of the trendlog using this method shall allow the viewing of the trendlog view.

g. Trendlog viewer shall provide:

(i) Software that is capable of graphing the trend logged object data shall be included.

(ii) Access and ability to create, edit and view are restricted to users by user account credentials

(iii) Specific and repeatable URL defines the trendlog(s) that comprise the view

(iv) Call out of trendlog value at intersection of trend line and mouse-over vertical axis.

(v) Trend log and companion logs can be configured to display on one of two independent vertical scales.

(vi) Click zoom for control of data set viewed along either graph axis.

(vii) User specifiable start and end dates as well as a fast scroll features that that supports click zoom of macro scale view of the data for quickly finding data set based on visual signature.

(viii) User export of the viewed data set to MS Excel.

(ix) Web browser based help

(x) Optional min/max ranges (Upper Control Limits, Lower Control Limits) for each value

7. Energy Log Information

a. AWS shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units.

b. All data shall be stored in database file format for direct use by third-party programs. Operation of system shall stay completely online during all graphing operations.

c. AWS Operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. System shall support using flow and temperature sensors for BTU monitoring.

d. AWS shall display archived data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.

8. Reports

a. AWS shall be capable of periodically producing reports of trendlogs, alarm history, tenant activities, device summary, energy logs, and override points. The frequency, content, and delivery are to be user adjustable.

b. All reports shall be capable of being delivered in multiple formats including text- and comma-separated value (CSV) files. The files can be printed, emailed, or saved to a folder, either on the server hard drive or on any network drive location.

9. Configuration/Setup

a. Provide means for operator to display and change system configuration. This shall include, but not be limited to, system time, day of the week, date of daylight savings set forward/set back, printer termination, port addresses, modem port and speed, etc. Items shall be modified using understandable terminology with simple mouse/cursor key movements.

10. Field Engineering Tools

a. AWS shall include field engineering tools for programming all controllers supplied. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. Graphical programming that uses simple rectangles and squares is not acceptable.

b. User shall be able to select a graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.

c. Programming tools shall include a real-time operation mode. Function blocks shall display real-time data and be animated to show status of data inputs and outputs when in real-time operation. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.

d. Field engineering tools shall also include a database manager of applications that include logic files for controllers and associated graphics. Operator shall be able to select unit type, input/output configuration and other items that define unit to be controlled. Supply minimum of 250 applications as part of workstation software.

e. Field engineering tool shall include Device Manager for detection of devices connected anywhere on the BACnet network by scanning of the entire network. This function shall display device instance, network identification, model number, and description of connected devices. It shall record and display software file loaded into each controller. A copy of each file shall be stored on the computer's hard drive. If needed, this file shall be downloaded to the appropriate controller using the mouse.

f. AWS automatically notify the user when a device that is not in the database is added to the network.

g. AWS shall include backup/restore function that will back up entire system to selected medium and then restore system from that media. The system shall be capable of creating a backup for the purpose of instantiating a new client PC.

h. The system shall provide a means to scan, detect, interrogate, and edit third-party BACnet devices and BACnet objects within those devices.

11. WEB Client

a. BMS supplier shall provide an HTML5 based browser access to the AWS as part of standard installation. User must be able to access all displays of real-time data that are part of the AWS using a standard Web browser. Web browser shall tie into the network through owner-supplied Ethernet network connection. The AWS must be able to support 20 concurrent web client users.

b. Browser shall be standard version of Microsoft Internet Explorer v10.0 or later, Firefox v19.0 or later and Chrome v24.0 or later. No special vendor-supplied software shall be needed on computers running browser. Data shall be displayed in real-time and update automatically without user interaction.

c. Web pages shall be automatically generated using HTML 5 from the data display files that reside on the AWS. Any system that requires use of an HTML editor for generation of Web pages shall not be considered.

d. Access through web client or thick client shall utilize the same hierarchical security scheme as the AWS. User shall be asked to log on once the client makes connection to the AWS. Once the user logs in, any and all changes that are made shall be tracked by the AWS. The user shall be able to change only those items he or she has authority to change. A user activity report shall show any and all activity of the users who have logged in to the system, regardless of whether those changes were made using a web client, thick client or through the AWS.

12. Backup / Restore

a. At the conclusion of project, contractor shall leave with owner a CD ROM that includes the complete software operation system and project graphics, set points, system parameters, etc. This backup shall allow the owner how to completely restore the system in the case of a computer malfunction.

D. Portable Operator's Terminal

1. The portable operator' terminals (POT) shall be a portable personal computer (PC) with an integral display, keyboard and drives. A communication connection shall be provided at each Personal Computer Operator Workstation, each Primary Control Panel and each Secondary Control Panel to provide the operator with operator to view the entire Building Management System network. In addition, a communication connection shall be provided at each Application Specific Terminal Equipment Controller for connection of the POT.

2. The monitoring and control functions of the Building Management System (BMS) shall be totally independent of the Personal Computer Workstation so that if the Personal Computer is off line (not operating), the Building Management System will continue to perform all of its monitoring and control functions.

3. When connected to a Personal Computer Operator Workstation, a Primary Control Panel or a Secondary Control Panel, the Portable Operator's Terminal shall be to control and monitor all of the functions that can be performed at the Personal Computer Operator Workstation.

4. The portable operator's terminal shall include a user-friendly, English language-prompted interface for quick access to system information.

5. The following criteria for the portable operator's terminal shall be a minimum and shall include but not be limited to:

a. Latest Pentium processor with a minimum speed of 4.0 GHz or equal alternate manufacturer

b. 120 Gigabyte hard disk

c. 2 GB SDRAM memory

d. Internal Ethernet adapter

e. Internal Wireless adapter

f. Minimum 15 inch integral display

g. Internal 8 x Speed DVD/CD ROM drive

h. Integral keyboard with full ASCII character set

i. Portable operator's terminal shall be powered by 120 VAC @ 60Hz and internal rechargeable batteries with a minimum of 4 hours of operation at full power.

j. Carrying Case designed to accommodate and protect operator's terminal.

k. The above requirements shall be considered a minimum for each Portable operator's terminal. The Building Management System manufacturer shall review the above and if not sufficient for the requirements of the project, provide portable operator's terminal with sufficient computing capability (including but not limited to processor speed/power, memory, local storage, etc.) to meet the system software minimum requirements, as well as with sufficient video display capabilities.

6. Software for the Portable Operator's Terminal shall be Windows 7, Windows 8, or Windows 8.1.

7. Functionality of the portable operator's terminal connected at any Control Panel, or Controller

a. Logon to system using same operator passwords utilized with PC operator workstation(s) and/or remote modem(s).

b. Access all network information from Control Panels, if authorized by password level.

c. Display all point, selected point, and alarm point summaries.

d. Display all trending and totalization information.

e. Add, modify, and/or delete any existing or new system point.

f. Command, change set point, enable/disable any system point.

g. Acknowledge all alarms.

h. Connect to local logging and report printer.

8. Simultaneous connection of all POTs to any control panel shall not:

a. Interrupt or interfere with normal network operation in any way.

b. Prevent alarms from being transmitted.

c. Preclude any centrally-initiated commands and/or system modification.

2.4 CONTROLLERS

1. BUILDING CONTROLLER

a. General Requirements

(i) BACnet Conformance

(a) Building Controller shall be approved by the BTL as meeting the BACnet Building Controller requirements.

(b) Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

(ii) Building controller shall be of scalable design such that the number of trunks and protocols may be selected to fit the specific requirements of a given project.

(iii) The controller shall be capable of panel-mounted on DIN rail and/or mounting screws.

(iv) The controller shall be capable of providing global control strategies for the system based on information from any objects in the system, regardless if the object is directly monitored by the building controller module or by another controller.

(v) The controller shall be capable of running up to six independent control strategies simultaneously. The modification of one control strategy does not interrupt the function or runtime others.

(vi) The software program implementing the DDC strategies shall be completely flexible and user-definable. All software tools necessary for programming shall be provided as part of project software. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site, using a WAN or downloaded through remote communications are not acceptable. Changing global strategies using firmware changes is also unacceptable.

(vii) Programming shall be object-oriented using control function blocks, and support DDC functions, All flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be supplied and be resident on workstation. The same tool shall be used for all controllers.

(viii) Programming tool shall provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed using the operator's workstation or field computer.

(ix) Controller shall have 6000 Analog Values and 6000 Binary Values

(x) Controller IP configuration can be done via a direct USB connect with a operator's workstation or field computer.

(xi) Controller shall have at a minimum a Quad Core 996Ghz processor to ensure fast processing speeds.

(xii) Global control algorithms and automated control functions shall execute using a 64-bit processor.

(xiii) Controller shall have a minimum of 1 GB of DDR3 SDRAM on a 533Mhz bus to ensure high speed data recording, large data storage capacity and reliability.

(xiv) Controller shall support two on-board EIA-485 ports capable of supporting various EIA-485 protocols including but not limited to BACnet MS/TP and Modbus.

(a) Ports are capable of supporting various EIA-485 protocols including but not limited to BACnet MS/TP and Modbus.

(xv) Controller shall support two gigabit speed Ethernet (10/100/1000) ports.

(a) Ports are capable of supporting various Ethernet protocols including but not limited to BACnet IP, FOX, and Modbus.

(xvi) All ports shall be capable of having protocol(s) assigned to utilize the port's physical connection.

(xvii) The controller shall have at a minimum four onboard inputs, two universal inputs and two binary inputs.

(xviii) Schedules

(a) Building controller modules shall provide normal seven-day scheduling, holiday scheduling and event scheduling.

(b) Each building controller shall support a minimum of 380 BACnet Schedule Objects and 380 BACnet Calendar Objects.

(xix) Logging Capabilities

(a) Each building controller shall log as minimum 2000 objects at 15 min intervals. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.

(b) Logs may be viewed both on-site or off-site using WAN or remote communication.

(c) Building controller shall periodically upload trended data to networked operator's workstation for long-term archiving if desired.

(d) Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.

(xx) Alarm Generation

(a) Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.

(b) Each alarm may be dialed out as noted elsewhere.

(c) Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.

(d) Controller must be able to handle up to 2000 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

b. BACnet MS/TP

(i) BACnet MS/TP LAN must be software-configurable from 9.6 to 115.4Kbps

(ii) Each BACnet MS/TP LAN shall support 64 BACnet devices at a minimum

(iii) All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

c. BACnet IP

(i) The building controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN.

(ii) Must support interoperability on WANs and CANs and function as a BACnet Broadcast Management Device (BBMD).

(iii) Each controller shall support at a minimum 128 BBMD entries

(iv) BBMD management architecture shall support 3000 subnets at a minimum

(v) Shall support BACnet Network Address Translation

(vi) All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

d. Expansion Ports

(i) Controller shall support two expansion ports.

(a) Combining the two on-board EIA-458 ports with fully loaded expansion ports the controller shall support 6 EIA-485 trunks simultaneously

(ii) Expansion cards that mate to the expansion ports shall include:

(a) Dual port EIA-485 card

(b) LON network card

e. Niagara Framework

(i) Controller shall utilize the Tridium Niagara Framework

(ii) Niagara Framework shall be version 3.8 or newer

(iii) All Niagara licensing shall be stored on a removable MicroSD card for fast in field replacement of controller

(iv) The Niagara License for the controllers shall be an open license

(v) The controller shall be programmable via Niagara Workplace programming tool

(vi) The controller shall be programmable via an Niagara embedded Workplace programming tool

f. Power Supply

(i) Input for power shall accept between 17¬–30VAC, 47–63Hz.

(ii) Optional rechargeable battery for shutdown of controller including storage of all data in flash memory

(iii) On-board capacitor will ensure continuous operation of real-time clocks for minimum of 14 days.

g. Controller shall be in compliance with the following

(i) UL 916 for open energy management

(ii) FCC Class B

(iii) ROHS

(iv) IEC 60703

(v) C-Tick Listed

h. Controller shall operate in the following environmental conditions:

(i) -4 to 149 °F (-20 to 65 °C) without optional battery, or 32 to 122 °F (0 to 50 °C) with optional battery

(ii) 0 to 95% RH, non-condensing

B. Advanced Application Control Panel

1. Control of AO's and BO's and monitoring of AI's and BI's are permitted on devices that conform to the requirements for the BACnet Advanced Application Controller (B-AAC) as identified in ASHRAE Standard 135. B-ASC's shall be provided with all supporting BACnet services as a local function. The device shall not depend upon any other devices for the functionality of schedule or alarm activities. Alternatively, the B-ASC's or B-BC's that the device is dependent upon shall utilize an Uninterruptible Power Supply (UPS). A single piece of equipment shall utilize a single controller. Control functions for a single piece of equipment may not be divided among controllers.

2. The Primary system control by Advanced Application Control Panels shall include but not be limited to:

a. VRF systems

b. Air Handling Units

c. Exhaust Fans

3. The intent of this specification is that the loss of any one Advanced Application Control Panel shall affect only points connected to that specific panel and shall not affect any other HVAC system.

4. Advanced Application Control Panels shall be installed with spare points (minimum of 10 percent of each type) and spare memory capacity for future connections. Provide all hardware software, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.

5. Provide all necessary hardware for a complete operating system as required. All hardware shall reside in each Advanced Application Control Panel. Advanced Application Control Panels shall not be dependent upon any higher level computer or another controller for operation.

6. Each Advanced Application Control Panel shall, at a minimum, be provided with:

    a. Appropriate NEMA rated enclosure.

    b. Power supplies as required for all associated modules, sensors, actuators, etc.

    c. Input/output point modules as required including spare capacity.

    d. Monitoring of all industry standard types of analog and digital inputs and outputs.

    e. Each Advanced Application Control Panel shall continuously perform self-diagnostics on all hardware and network communications.

    f. Each Advanced Application Control Panel shall provide battery backup to support the real-time clock and all memory and programs for a minimum of 72 hours.

    g. Each Advanced Application Control Panel shall support firmware upgrades without the need to replace hardware.

    h. Each controller shall support its associated secondary network(s).

    i. Isolation shall be provided at all Advanced Application Control Panel terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.

7. Advanced Application Control Panel Software

    a. Provide all necessary software for a complete operating system as required. All software shall reside in each Advanced Application Control Panel. Advanced Application Control Panels shall not be dependent upon any higher level computer or another controller for operation.

    b. All points, panels and programs shall be identified by a point descriptor. The same names shall be displayed at both the Advanced Application Control Panel (s) (via portable terminal, printer or modem) and the PC operator workstation(s). In addition to the point's descriptor and the time and date, the user shall be able to print, display or store an alarm message to more fully describe the alarm condition or direct operator response. Alarm messages shall be coordinated with the Owner.

c. All digital points shall have a user-defined, two-state status indication.

d. Each Advanced Application Control Panel shall, at a minimum, be provided with software for:

(i) Two-position control, proportional control, proportional plus integral control, proportional, integral, plus derivative control algorithms, all with automatic control loop tuning.

(ii) Limiting the number of times each piece of equipment may be cycled within any one-hour period.

(iii) The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads. Upon the resumption of power, each DDC Controller 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 operations.

(iv) Energy management routines including time of day scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides, start-stop time optimization, automatic daylight savings time switch over, night setback control, enthalpy switch over, peak demand limiting, temperature-compensated duty cycling, heating / cooling interlock, supply temperature reset, priority load shedding, and power failure restart.

(v) Custom, job-specific processes defined by the user, to automatically perform calculations and special control routines and sequences of operations.

(a) It shall be possible to use any system measured point data or status, any system calculated data, a result from any process or any user-defined constant in any controller in the system.

(b) Any process shall be able to issue commands to points in any and all other controllers in the system.

(c) Processes shall be able to generate operator messages and advisories to other operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.

(d) The custom control programming feature shall be documented via English language descriptors.

(vi) Generate and receive automatic and manual operator messages and advisories.

(vii) Interactive HELP function to assist operators connected via POTs and modems.

(viii) Comment lines for all programs.

(ix) Distributed, independent alarm analysis and filtering. Reporting of selected alarms during system shutdown and start-up shall be automatically inhibited. A minimum of six priority levels shall be provided for each point.

(x) Automatically accumulate and store run-time hours for all digital points.

(xi) Automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and pulse input type points.

e. Trend data shall be stored at the Primary Control Panels and automatically uploaded to the PC workstation. All trend data shall be available for use in any 3rd party personal computer applications located in the BMS

f. Advanced Application Control Panels shall be able to assign password access and control priorities. The logon password (at any PC workstation(s) or portable operator terminal) shall enable the operator to monitor, adjust and/or control only the systems, programs, primary control panel, and/or secondary control panels that the operator is authorized for. Passwords and priority shall be fully programmable and adjustable.

g. Advanced Application Control Panels shall be able to access any data from, or send control commands and alarm reports directly to, any other Advanced Application Control Panel or combination of controllers on the network without dependence upon a central or intermediate processing device. Advanced Application Control Panels shall also be able to send alarm reports to multiple operator workstations without dependence upon a central or intermediate processing device.

h. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.

(i) All alarm or point change reports shall include the point's English language description and the time and date of occurrence.

(ii) The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. Priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.

(iii) Alarm reports and messages will be directed to a user-defined list of operator devices or PC's.

(iv) In addition to the point's descriptor and the time and date, the user shall be able to print, display or store the alarm message to more fully describe the alarm condition or direct operator response.

(v) Each DDC Controller shall be capable of storing a library of at least 50 alarm messages. Each message may be assignable to any number of points in the Controller.

i. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for all points.

(i) DDC Controllers shall store point history data for selected analog and digital inputs and outputs:

(a) Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of l minute to 7 days shall be provided.

(b) Trend data shall be stored at the DDC Controllers and automatically uploaded to the workstation. Uploads shall occur based upon user-defined interval, manual command or automatically. All trend data shall be available for use in any 3rd party personal computer applications.

(c) DDC Controllers shall also provide high resolution sampling capability for verification of control loop performance.

j. DDC Controllers shall automatically accumulate and store run-time hours for all digital input and output points.

k. DDC Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and digital pulse input type points.

l. DDC Controllers shall count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly and monthly basis for all points

m. If the AACP supports a secondary network, provide necessary interface cards at the AACP

n. Failure of any AACP, shall be reported at the PCOW as a critical alarm.

o. Failure of a AACP shall not effect the operation of any other control panels or controllers connected to the network.

p. AACP shall include but not be limited to the following application package as determine by the Building Management System architecture (Option 1 or Option 2) for analysis, storage, retrieval and presentation of data

(i) Monitoring and control software

(ii) Alarm notification

(iii) Graphical Display

(iv) Dynamic Graphical Trending

(v) Historical Data Trends

(vi) Psychometric Properties

(vii) Equipment Run-time Totalization

(viii) Energy Usage and Demand

(ix) Thermal Energy Usage

(x) Measurement and Verification Data (Graphical display and reporting to meet requirements of LEED)

C. Application Specific Controllers

1. Control of AO's and BO's and monitoring of AI's and BI's are permitted on devices that conform to the requirements for the BACnet Application Specific Controller (B-ASC) as identified in ASHRAE Standard 135. Where B-ASC's are utilized, any supporting B-BC or B-ASC must be provided with an Uninterruptible Power Supply (UPS) to avoid any unintentional loss in the support of BACnet services due to a power outage for the B-BC while the B-ASC is functional.

2. Application Specific Controller (ASC) for terminal equipment only. The terminal equipment shall include but not be limited to:

a. Fan Coil (AC) Units

b. Fans with start/stop requirements only (3 fans maximum)

c. Unit Heaters, Cabinet Heaters, etc. (if control from the BMS is required)

d. Electric Duct Heaters

e. All other types of equipment shall be controlled by panels meeting the requirements for ASC.

3. The intent of this specification is that the loss of any one Application Specific Controller shall affect only points connected to that specific Application Specific Controller and shall not affect any other HVAC system Application Specific Controller Application

4. Application Specific Controller (ASC) Hardware

a. All Application Specific Controllers shall be installed with spare points (minimum 10 percent of each type) and spare memory capacity for future connections. Provide all hardware software, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.

b. Provide all necessary hardware for a complete operating system as required. All hardware shall reside in each Application Specific Controller. Application Specific Controllers shall not be dependent upon any higher level computer or another controller for operation.

c. Failure of the ASC shall be reported as a critical alarm to the AWS.

d. ASC associated with terminal equipment that has its own electrical power shall be powered from the equipment served. ASC associated with terminal equipment that does not have a power supplied, shall have its own electrical power supply.

e. Provide each ASC with its own software time clock synchronized from the real-time clock at the AACP

f. Battery back-up for volatile memory and software time clock. Battery back-up for each shall have a minimum of 72 hours at full operation and a minimum of five (5) year life and readily field replaceable.

g. Where required by control panel application, interfaces to field instrumentation, final control sequences, etc. shall be provided a Input/output modules that

(i) Enable the AACP to receive signals from digital and analog instrumentation.

(ii) Enable the AACP to output control signals to the final control sequence.

Input/output module shall be either integral with the controller board or a plug-in type module

Input/output module accommodate

(iii) Analog and Digital inputs

(iv) Analog and Digital outputs

(v) Pulse Input

Input/output modules shall include troubleshooting LED indicators

h. ASC shall include a connection port to allow for the connection of either a HHOI Device. For equipment controlled by a ASC that is concealed or above a hung ceiling, connection port shall also be provided at room temperature sensor.

i. ASC shall include all appurtenances (relays, pressure transducers, transformers, etc.) required to perform specified control sequences.

j. All application programs and operating sequence shall reside in the ASTEC however, data based changes shall be initiated from the AWS or HHOI Device.

D. Application Specific Control (ASC) Software

1. Provide all necessary software for a complete operating system as required. All software shall reside in each Application Specific Control Panel. Application Specific Control Panels shall not be dependent upon any higher level computer or another controller for operation.

2. All points, panels and programs shall be identified by a point descriptor. The same names shall be displayed at both the Application Specific Control Panel(s) (via portable terminal, printer or modem) and the PC operator workstation(s). In addition to the point's descriptor and the time and date, the user shall be able to print, display or store an alarm message to more fully describe the alarm condition or direct operator response. Alarm messages shall be coordinated with the Owner.

3. All digital points shall have a user defined, two state status indication.

4. ASC shall include but not be limited to the following application package as determine by the Building Management System architecture for monitoring and control, operating sequences, analysis, storage, retrieval and presentation of data:

a. Monitoring and Control Software

b. Alarm Notification

c. Graphical Display

d. Dynamic Graphical Trending

e. Equipment Run-time Totalization

f. Energy Usage and Demand

g. Thermal Energy Usage

h. Measurement and Verification Data (Graphical display and reporting to meet requirements of LEED)

5. Each Application Specific Controller shall continuously perform self-diagnostics on all hardware and secondary network communications. The ASC shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failure to establish communication to the system.

2.5 INPUT DEVICES

A. General

1. All devices and equipment shall be approved for installation.

2. Provide the following field devices as required by the monitoring, control and optimization functions listed elsewhere in this specification.

3. All sensor signals shall be via a 4-20 ma loop.

B. Analog Inputs

1. Temperature Sensors (Not Including Space Temperature Sensors)

a. All temperature sensors shall use RTD (Resistance Temperature Detector) elements. All control signals shall be via a 4-20 ma loop.

b. Calibration adjustments: Zero & Span.

c. Any point, physical or calculated may be designated for trending.

d. Range:

(i)	Liquid Immersion Temperature	+20/+120 F, +70/+220 F
(ii)	Duct (Single Point) Temperature	+20/+120 F, +70/+220 F
(iii)	Duct (Averaging) Temperature	+20/+120 F
(iv)	Outside Air Temperature	-50/+122 F

e. Outside air temperature sensor shall include

(i) Ventilated sun shield

(ii) Weatherproof enclosure with conduit fitting

(iii) Accuracy; ± 1.0°F

(iv) Sensor length 3 inches

(v) Stainless steel probe with nickel or platinum sensor element

f. Duct mounted (single point) temperature sensor shall include

(i) Length; 2/3rd of the duct width but not less than 12 inches

(ii) Stainless steel probe with nickel or platinum sensor element

(iii) Moisture/waterproof enclosure with conduit fitting

(iv) Accuracy; ± 1.0°F

g. Duct mounted (averaging) temperature sensor shall include

(i) Length one linear foot per square foot of duct cross-section but not less than 12 feet. Where sensor required length exceeds standard manufacturer's length, provide multiple sensors in a series-parallel network arrangement.

(ii) Protected probe with nickel or platinum sensor element

(iii) Moisture/waterproof enclosure with conduit fitting

2. Space Temperature Sensors

a. RTD or thermistor type

b. Accuracy: +0.5 F

c. Operating Range: 80 Degree Range Maximum

d. Set point Adjustment Range: 55 to 95 F

e. Shall include a terminal jack integral to the sensor assembly to allow the operator to query and modify operating parameters of the local room terminal unit from the portable operator's terminal (POT) or hand held operator interface (HHOI) device.

f. Concealed set point adjustment switch with software limits.

g. Push-button override switch. The override switch may be locked out, overridden, or limited as to time through software by an authorized operator.

h. Room sensors shall not be located on outside walls.

i. The length of wiring from the space temperature sensor to the controller shall not exceed 100 ft.

j. Temperature sensors shall be reviewed and approved by owner and architect for finish and style selection.

3. Outdoor Relative Humidity Sensor

a. Housing sensor design to shield from the effects of wind and sun and to allow maximum airflow over the sensor

b. Weatherproof ABS plastic enclosure (NEMA 4 rating)with conduit fitting

c. Proportional 4 to 20 mA for a relative humidity range of 5 to 100 percent

d. Temperature operating range for sensor -4°F below to 140°F

e. Accuracy; ± 3.0 percent over full relative humidity range @ 68°F.

f. Stability; ± 2.0% RH over two years

g. Resolution; 0.1% RH

h. Temperature Dependence; <± 1.5% RH from 14°F to 140°F

i. Furnish Automation Components Inc. A/RH series, Amphenol GEH3 series or equal as approved by engineer.

4. Duct Mounted Relative Humidity Sensor

a. Moisture/waterproof plastic enclosure with conduit fitting

b. Corrosion resistance probe with Proportional 4 to 20 mA for a relative humidity range of 5 to 100 percent

c. Operating Range of sensor 32°F to 125°F; 0 to 100% with maximum dew point 85°F.

d. Accuracy; ± 2.0 percent over a range of 20 to 80 % and ± 4.0 percent 10 to 20 % and 80 to 90%

e. Repeatability; 0.5%

f. Drift; 2.0% over 5 years

g. Duct Probe; 95 -5V flammability per UL 94

h. Duct Probe Length; As required for width of duct or minimum 6.25 inches

i. For Duct Mounted Relative Humidity Sensor that is used as a high limit, provide relay and fixed differential to signal BMS on high duct humidity.

j. Certified compliant with National Institute of Standards and Technology (NIST) guidelines

k. Furnish Automation Components Inc. A/RH series, Amphenol GEH3 series or equal as approved by engineer.

5. Wall Mounted Relative Humidity Sensor

a. Moisture/waterproof PC/ABS plastic enclosure with conduit fitting

b. Corrosion resistance probe with Proportional 4 to 20 mA for a relative humidity range of 5 to 100 percent

c. Operating Range of sensor 32°F to 122°F; 0 to 100% with maximum dew point 85°F.

d. Accuracy; ± 2.0 percent over a range of 20 to 80 % and ± 4.0 percent 10 to 20 % and 80 to 90%

e. Response Time; within 5% RH of actual within 15 minutes

f. Certified compliant with National Institute of Standards and Technology (NIST) guidelines.

g. Furnish Automation Components Inc. A/RH series, Amphenol GEH3 series or equal as approved by engineer.

6. Dew Point Sensors

a. Accuracy: + 2.0 Fdp

b. Range: -40/+115 F DP

c. Furnish Vaisala, Amphenol or equal as approved by engineer.

7. Air Differential Pressure Sensor

a. Range

(i) Duct Mounted Sensor; 0.05 to 2.0 0.05 to 3.0 inches wg Static Pressure

(ii) Room Sensors; -0.1 to +0.1 -0.5 to +0.5 -1.0 to +1.0 wg inches Static Pressure

(iii) Filter Monitoring; Range as required for fan application; Adjustable Set point; differential pressure

(iv) For applications with negative to positive pressure ranges, provide an "elevated Zero" at midpoint of pressure range.

b. Transmitter Output Signal; 4 to 20 mA or 0 to 10 VDC proportional to pressure input range

c. Transmitter Operating Range; 32°F to 125°F

d. Transmitter Span or zero adjustment; accessible with a 20-turn potentiometer for fine resolution.

e. Transmitter Accuracy; ± 1% of span (including non-linearity and hysteresis)

f. Pressure Sensing Element; Differential capacitance cell or piezoresistive (silicon) sensors for pressure measurements

g. Transmitter ports shall include air filter

h. Transmitter monitoring for fan shut down, provide where require two normal closed SPST contactors. One for alarm and one for fan shut down. Contactors shall be rated for fan controller requirements but not less than 10 amps @ 120 volts

i. Transmitter monitoring for fan status, provide where require two normal closed SPST contactors. Contactors shall be rated for fan controller requirements but not less than 10 amps @ 120 volts

j. Transmitter Inlet Ports; ¼ inch suitable for piping from transmitter to static pressure sensor

k. Where required, transmitter shall be UL approved

l. Transmitter shall be capable accepting pressure signals as following depending on application:

(i) Positive pressure only

(ii) Negative Pressure only

(iii) Two Positive Pressure

(iv) Two Negative Pressure

(v) One Positive Pressure and One Negative

m. Static Pressure Sensor (Duct)

(i) ¼ inch stainless steel tube with a minimum or 4 radially drilled sensing holes suitable for duct velocities of 12,000 FPM

(ii) Insertion depth; 6 inch for ductwork less than 20 inches; 12 inch for ductwork 20 inches and greater.

(iii) Provide mounting flange with gasket

(iv) For room pressure sensors, provide stainless steel pressure sensor for direct mounting to wall or mounted to a standard electrical box.

(v) For room pressure sensors and outdoor pressure sensors, provide surge dampers to overcome sudden pressure changes due to wind gust or opening and closing of doors.

(vi) Total Pressure Sensor; where required, provide a ¼ inch stainless steel tube with a single sensing opening facing direction of flow. Insertion depth same as described above.

(vii) Tubing Length & Diameter; Diameter of tubing between transmitter and sensor per manufacturer's recommendation for installation distance

8. Airflow Measurement Devices (AMD)

a. Provide one Airflow Measurement Device (AMD) for each measurement location provided on the plans, specifications, schedules and/or control diagrams to determine the average airflow rate and temperature at each measurement location.

b. Each AMD shall be provided with a microprocessor-based transmitter and one or more sensor probes.

c. Products described in this subparagraph shall be Listed and labeled in accordance with the UL and having been tested in accordance with standard UL 873 – Airflow Indicating Equipment as a complete and functional assembly by an independent testing agency. The AMD shall be BTL Listed.

d. Measurement devices included in this subparagraph

(i) Duct and plenum mounted airflow measurement devices

(ii) Fan inlet mounted airflow measurement devices

e. Subject to compliance with performance and design requirements of this Section, provide products that comply with this specification by one of the following vendors:

(i) EBTRON, Inc. Model GTx116-P+ (basis of design)

(ii) Kurz Instrument

(iii) Fluid Components International (FCI)

f. Airflow measurement devices shall use the principle of thermal dispersion and provide one self-heated bead-in-glass thermistor and one zero power bead-in-glass thermistor at each sensing node.

g. Fan Inlet measurement devices shall not be used unless indicated on drawings or required by these specifications. Fan Inlet measurement devices shall not be substituted for duct and plenum measurement devices.

h. Sensor Probes

(i) Sensor probes shall be constructed of gold anodized, 6063 aluminum alloy tube insert 316 stainless steel tube in lieu of 6063 aluminum alloy tube, when required.

(ii) Sensor probe mounting brackets shall be constructed of 304 stainless steel.

(iii) Probe internal wiring between the connecting cable and sensor nodes shall be Kynar coated copper.

(iv) PVC jacketed internal wiring is not acceptable.

(v) Probe internal wiring connections shall consist of solder joints and spot welds.

(vi) Connectors of any type within the probe are not acceptable.

(vii) Printed circuit boards within the probe are not acceptable.

(viii) Probe internal wiring connections shall be sealed and protected from the elements and suitable for direct exposure to water.

(ix) Each sensor probe shall be provided with an integral, FEP jacket, plenum rated CMP/CL2P, UL/CUL Listed cable rated for exposures from -67°F to 392 °F (-55° C to 200° C) and continuous and direct UV exposure.

(x) Plenum rated PVC jacket cables are not acceptable.

(xi) Each sensor probe cable shall be provided with a connector plug with gold plated pins for connection to the transmitter.

(xii) Each sensor probe shall contain one or more independently wired sensing nodes.

(xiii) Sensor node airflow and temperature calibration data shall be stored in a serial memory chip in the cable connecting plug and not require matching or adjustments to the transmitter.

(xiv) Each sensor node shall be provided with two bead-in-glass, hermetically sealed thermistors potted in a marine grade waterproof epoxy.

(xv) Each thermistor shall be individually calibrated at a minimum of 3 temperatures to NIST-traceable temperature standards.

(xvi) Each sensor node shall be individually calibrated to NIST-traceable airflow standards at a minimum of 16 calibration points.

(xvii) The number of independent sensor nodes provided shall be as follows:

Duct or Plenum Area (sq. ft.)	Total Number of Sensors per Location
Less than 1.0	2
1.0 to 4.0	4
4.1 to 8.0	6
8.1 to 12.0	8
12.0 to 16.0	12
Greater than 16.0	16

A total of 4 probes shall be required for openings with an aspect ratio ≤ 1.5 and with an area ≥ 25 ft^2 (≥ 2.32 m^2).

i. Transmitter

(i) A remotely located microprocessor-based transmitter shall be provided for each measurement location.

(ii) The transmitter shall be comprised of a main circuit board and interchangeable interface card.

(iii) All printed circuit board interconnects, edge fingers, and test points shall be gold plated.

(iv) All printed circuit boards shall be Electroless Nickel Immersion Gold (ENIG) plated.

(v) All receptacle plug pins shall be gold plated.

(vi) The transmitter shall be capable of determining the average airflow rate and temperature of the sensor nodes.

(vii) Separate integration buffers shall be provided for display airflow output, airflow signal output (analog and network) and individual sensor output (IR-interface).

(viii) The transmitter shall be capable of providing a high and/or low airflow alarm.

(ix) The transmitter shall be capable of identifying an AMD malfunction via the system status alarm and ignore any sensor node that is in a fault condition.

(x) The transmitter shall be provided with a 16-character, alpha-numeric, LCD display.

(xi) The airflow rate, temperature, airflow alarm and system status alarm shall be visible on the display.

(xii) The transmitter shall be provided with two field selectable (0-5/0-10 VDC or 4-20mA), scalable, isolated and over-current protected analog output signals and select one or both of the following

(a) One isolated RS-485 (field selectable BACnet MS/TP or Modbus RTU) network connection; or

(b) One isolated Ethernet (simultaneously supported BACnet Ethernet or BACnet IP, Modbus TCP and TCP/IP) network connection.

(xiii) Analog output signals shall provide the total airflow rate and be field configurable to output one of the following:

(a) temperature

(b) airflow alarm

(c) system status alarm

(xiv) Network communications shall provide the average airflow rate, temperature, airflow alarm, system status alarm, individual sensor node airflow rates and individual sensor node temperatures.

(xv) The transmitter shall be capable of communicating with other devices using one of the following interface options:

(a) Linear analog output signals for airflow and temperature: Field selectable, fuse protected and electrically isolated from all other circuitry, 0-5VDC / 0-10VDC / 4-20mA (4-wire)

(b) RS-485: Field selectable BACnet-MS/TP or Modbus-RTU

(1) BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.

(xvi) The transmitter shall be powered by 24 VAC and use a switching power supply that is over-current and over-voltage protected.

(xvii) The transmitter shall use a "watchdog" timer circuit to ensure continuous operation in the event of brown-out and/or power failure.

j. Performance

(i) Each sensing node shall have an airflow accuracy of ±2% of reading over an operating range of 0 to 5,000 FPM (25.4 m/s).

(ii) Accuracy shall include the combined uncertainty of the sensor nodes and transmitter.

(iii) Devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter shall demonstrate compliance with this requirement over the entire operating range.

(iv) Each sensing node shall have a temperature accuracy of ±0.15° F (0.1° C) over an operating range of -20° F to 160° F. (-28.9° C to 71° C).

(v) The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location either called for on the drawing or in this specification.

(vi) A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's placement requirements.

(vii) After installation of measurement devices shall not be adjusted without approval in writing from the consulting mechanical engineer. If approval is given for adjustment, HVAC Contractor shall only make the adjustment with the assistance of an manufacturers authorized representative.

9. Space and Duct Carbon Dioxide Sensors

a. The sensor shall use non-dispersive infrared (NDIR) analyzers designed for measuring environmental CO2 concentration in ventilation systems and indoor spaces. The measurement range shall be 0-2000ppm.

b. Sensor accuracy shall be ±30 ppm ±2% of measured value with repeatability of ±20 ppm ±1% of measured value and a response time of <60 seconds for 90% step change.

c. The sensor shall have self-calibration algorithm with a calibration interval of 5 years.

d. Input power shall be 20 to 30 VDC/24VAC; 100mA maximum.

e. The output shall be 4-20mA/0-10V selectable with an available alarm relay for direct ventilation control.

f. The operating temperature range shall be32ºF to 122 ºF and the operating humidity range shall be 0 to 95% RH noncondensing.

g. Must comply with ASHRAE 62.1-2004 standard for air quality.

h. The sensor shall Veris CDE/CWE, or equal approved by engineer.

C. Binary Inputs

1. Differential Pressure Switch, Air

a. Diaphragm Material; Silicone

b. Housing; Zinc coated steel with NEMA 1 rating

c. Adjustable set point

d. Switch: Single pole; double throw (SPDT) (snap-action) pilot duty rated at 125VA. Enclosure connection cover

e. Port Sizing; ¼ inch barbed slip-on connection

f. Unit Mounting; Diaphragm in vertical position only

g. Provide sensing probe kit. Two probes required for differential pressure

h. Pressure Range; Suitable for equipment being monitored.

i. Furnish Cleveland Controls AFS-460 or equal as approved by engineer.

2. Freezestats

a. Furnish and install, for each air handling unit with outdoor air connections, a low temperature safety thermostat (freezestat) with a 20 ft. sensing element.

b. There shall be one freezestat per coil section.

c. Element shall be installed in a serpentine fashion across the inlet of the cooling coil in the air stream.

d. Element shall be arranged to stop the unit supply fan and its associated return air fan should the temperature at any point along the sensing element fall below 35ºF for an adjustable time period.

e. Low temperature detector shall be automatic reset, DPDT type.

f. Provide manual reset button at primary control panel and time delay relay to lockout fan if freeze condition exists for more than 60 seconds. Time delay relay shall be adjustable up to 5 minutes.

g. Furnish Honeywell L480G or equal as approved by engineer.

3. Current Sensing Relay

a. Provide and install current sensing relays for all motor where points list requires equipment status.

b. Sensor shall be split core, two wire, loop powered and sized for expected amperage. Unit shall be UL listed.

c. Provide status LEDs for current sensed below set point, current sensed above set point and loop power failure. The unit shall automatically range itself and have solid state outputs.

d. Furnish RIBXGTA by Functional Devices, Inc. or equal as approved by engineer.

4. Single Point Leak Detector

a. The leak detector shall provide a single point detection of leaks. The point detection sensor shall have two gold-plated sensing probes to prevent corrosion resistance and to provide accurate readings. Mounting brackets shall allow for sensor height adjustment and leveling.

b. The leak detector shall constantly monitor points for leaks, internal faults and power failures and warn of any abnormal conditions. The leak detector module shall indicate that water has contacted the sensors by actuating two output relays. The relays shall remain activated until the module is reset.

c. Provide Liebert LT-410 or engineer approved equal.

5. Zone Leak Detector

a. The alarm module shall indicate that water has contacted the sensors cable by actuating two output relays. The relays shall remain activated until the module is reset.

b. Provide Liebert LT -460 or equal.

6. Single Point Leak Detector

7. The Liqui-tect 410 (LT410) provides a single-point detection of leaks. The point detection sensor has two gold-plated sensing probes to prevent corrosion resistance and to provide accurate readings. The LT410 constantly monitors points for leaks, internal faults and power failures and warns of any abnormal conditions. Mounting rackets allow for sensor height adjustment and leveling.The LT410 is the ideal olution for sensing leaks under a raised computer floor or air conditioning drip pans. Two independent outputs provide added flexibility with the capacity to signal both a local alarm panel and a remote building management system or external equipment.

D. Miscellaneous Monitoring Systems

1. Commercial Energy Consumption Meter

a. The Energy Meter shall consist of digital electronic circuitry.

b. The Energy Meter shall conform to ANSI C12.1 metering accuracy standards.

c. The Energy Meter system shall consist of a meter and included CT(s) calibrated together as a system.

d. The Energy Meter's system accuracy shall be +/- 1% from 2 % to 100 % of the rated current over a temperature range of 32-122° F.

e. The Energy Meter shall require no annual recalibration by users in the field.

f. The Energy Meter shall derive operating power from its metering connections, and shall not require a separate control power connection.

g. The Energy Meter electronics shall automatically correct for CT phase reversal.

h. The Energy Meter CTs shall be factory assembled.

i. The Energy Meter shall have a backlit LCD display measuring 1.2" X 3.8" that is direct read without the need for multipliers.

j. The Energy Meter LCD display shall show accumulated kWh on the top half of the display while the bottom half of the display scrolls through Amps, Voltage, PF, KVAR, KVA, KW Real Power, as stated in point q below.

k. The Energy Meter shall meet UL and cUL specifications as listed in 3111-1.

l. The Energy Meter shall directly accept any voltage input from 120-480 VAC.

m. The Energy Meter shall be internally isolated to 2500 VAC.

n. The Energy Meter series shall have models available for amperage ranges of 100-2400 Amps.

o. The Energy Meter shall have a N.O. pulse output with selectable pulse output rates of 0.10, 0.25, 0.50, or 1.00 kWh per pulse.

p. The Energy Meter shall have a N.C. phase-loss alarm output operating at 100mA @ 24VAC/DC.

q. Using the optional Communications Board, the Energy Meter shall be networkable via an RS485 connection to a Modbus RTU network.

r. The information and capabilities provided by the Energy Meter shall include the following:

(i) Current, per phase & three-phase total

(ii) Voltage, per phase & three-phase total, phase-to-phase & phase-neutral

(iii) Real Power (kW), per phase & three-phase total

(iv) Reactive Power (kVAR), three phase total

(v) Apparent Power (kVA), three phase total

(vi) Power Factor, per-phase & three-phase total

(vii) Real Energy (kWh), three phase total

s. Furnish H8163 Series supplied by Veris Industries or equal as approved by engineer.

2. Water Leak Detection System

a. General

(i) Furnish and install a complete water detection system for each area specified. The system shall include electronic alarm and locating modules, sensing cable, graphic maps and all auxiliary equipment. The system shall simultaneously detect the presence of water at any point along the cable's length, sound an alarm, and pinpoint the distance to the leak. The sensing cable shall be of such construction that no metallic parts shall be exposed to the environment. The system shall provide pre-connecterized sensing cable and components. The system shall be UL listed and FM approved.

(ii) The water leak detection system shall be installed in the following areas: (Add locations for water leak detection system).

(iii) The system shall be as manufactured by Raychem Corporation or equal.

(iv) Provide two sets of test instrumentation to owner.

b. Locating leak detection panel (TTB-FA)

(i) The alarm and locator module, TTB-FA, shall monitor up to a maximum of 1000 feet of sensing cable. The alarm module shall indicate that water has contacted the sensing cable by sounding an audible alarm, actuating an output relay, sending a proportional 4-20 ma signal to the BMS and displaying the distance from the start of the sensing cable to the start of the first contact with water. The location of the first water contact shall be retained on the display until the cable is dry and the module is updated.

(ii) The alarm module shall be capable of detecting the presence of a 1 inch leak anywhere along the cable with a repeatability of +/- 1%.

(iii) The alarm module shall continuously monitor the sensing cables and interconnecting cables for continuity. Any break in the cable shall generate an audible alarm, activate an output relay and activate a "continuity" LED on the face of the module.

(iv) The alarm module shall have LED's indicating "power" (green), "alarm" (red) and "continuity" (yellow). The module shall be equipped with exposed test, reset and silence buttons. All other functions shall require key access.

(v) The alarm module shall be powered by emergency power.

(vi) The module enclosure shall be a minimum of 16 gauge steel, flush mounting type.

c. Single point leak detector

(i) The alarm module, TTC, shall monitor up to a maximum of 50 feet of sensing cable. The alarm module shall indicate that water has contacted the sensing cable by sounding an audible alarm and actuating an output relay. The relay shall remain activated until the cable is dry and the module is reset.

(ii) The alarm module shall be capable of detecting the presence of a 1 inch leak anywhere along the cable with a repeatability of +/- 1%.

(iii) The alarm module shall continuously monitor the sensing cables and interconnecting cables for continuity. Any break in the cable shall generate an audible alarm, activate an output relay and activate a "continuity" LED on the face of the module.

(iv) The alarm module shall have LED's indicating "power" (green), "alarm" (red) and "continuity" (yellow).

(v) The alarm module shall be powered by emergency power.

(vi) The module shall be mounted in a field equipment cabinet.

d. Water sensing cable

(i) The water sensing cable (TT-1000) shall detect the presence of water and pinpoint its location. The cable shall consist of four wires: Two sensor wires, a continuity wire and a return wire. All four wires shall be coated and insulated with a fluoropolymer and wound helically around a flouropolymer core. The cable shall have a breaking strength, including connectors, of at least 70 pounds, per ASTM D-638. The cable shall have an abrasion resistance of >65 cycles, per UL 719.

(ii) The sensing cable shall offer distributed sensing with the ability to detect the location of water at any point along the length of the cable. The cable shall be flexible, and carry less than 24VDC under normal conditions.

(iii) The system shall not alarm when in contact with any metallic equipment such as drip pans, floor tile supports, conduit, etc.

(iv) The cable shall be available in modular, pre-connectorized lengths of 5, 10, 15, 25 and 50 feet. Field splicing shall not be acceptable.

(v) The cable shall be UL 910 rated and plenum rated per NEC 725-2(b).

e. Jumper cable

(i) Jumper cable shall be used where leak detection cable is not required but continuity is required (in raceways between alarm module and floor surface, etc.). The jumper cable shall be plenum-rated and jacketed with fluoropolymer materials, as per NEC 725-2(b). The jumper cable shall consist of four different color (Y, B, R, G), insulated 18 AWG wires and shall be available in pre-connectorized lengths of 5, 10, 15, 25 and 50 feet.

f. Accessories

(i) Provide all end connectors, leader cables, hold down clips, caution tags, spray adhesive (3M 90M) as required.

g. Graphic display map

(i) Provide a graphic display map for each room served. The map shall be a 1/8 in = 1.0 ft scaled drawing of the area served, indicating actual equipment locations, floor tile and other points of reference. The actual cable routing shall be clearly marked on the map with actual scaled distances every 10 feet.

(ii) A dynamic graphic display, equivalent to the aforementioned map, shall be duplicated on the BMS operator workstation. The area in alarm (within 5 feet) shall blink in red until the alarm is cleared.

h. Performance

(i) A maximum wetted area of 2 inches of cable, at any point along the entire length of cable, shall activate an alarm.

(ii) The system shall be continuously monitored for continuity. The loss of continuity shall cause an alarm within 5 seconds.

(iii) The cable shall be capable of being cleaned with a clean dry cloth, in place.

(iv) The cable shall dry and reset the module immediately upon removal from free water. No shaking, wiping or mechanical action shall be required.

i. Installation

(i) All system components shall be installed in accordance with the manufacturer's recommendations. The manufacturer shall provide necessary installer training and supervision as required.

(ii) The cable shall be installed on clean, dry finished surfaces only (coordinate access and schedule installation as required) after the possibility of physical damage has been eliminated. The cable shall be fastened to the surface it is monitoring every 4 feet with hold down clips and spray mastic adhesive. Hold down clip installation shall be subject to spot checks during commissioning. If any clip fails, all other clips shall be re-attached and re-tested, at no additional cost.

(iii) The system shall be commissioned prior to acceptance. Submit a test procedure for approval.

j. Warranty

(i) All equipment shall be warranted to the same extent as the BMS system, or per the manufacturer's warranty, whichever is greater.

3. Audio/Visual Alarm Units

a. Provide one (1) audio/visual alarm unit(s) that shall be located if required.

b. Each audio/visual alarm unit shall include a 1" x 3" translucent illuminated rectangular alarm light ("BMS Alarm"), a Sonalert horn (hidden), a silence switch with stainless steel cover plate to match mounting surface. When any BMS alarm occurs (as coordinated with facilities personnel), the alarm light shall flash once per second (adjustable) and the horn shall sound. When the silence switch is pushed, the horn will silence and the pilot light shall light continuously until alarm is cleared.

c. The BMS shall monitor the alarm light, horn and silence switch status.

d. Provide 1/8 inch high engraved and painted lettering for operational instructions as required by the owner on the cover plate

2.6 OUTPUT DEVICES

A. General

1. All devices and equipment shall be approved for installation.

2. Provide the following field devices as required by the monitoring, control and optimization functions listed elsewhere in this specification.

B. Actuation

1. Electric

a. All damper actuation shall be electric. Pneumatic actuation is not acceptable.

2. Incremental Electronic Actuator for Terminal Equipment Damper Actuation

a. Incremental (floating) actuators shall be allowed for terminal equipment only.

b. Actuators shall be proportional, electronic, direct-coupled actuators used for modulating service. Actuators shall be equipped with metal housings and visual stroke indicators.

c. Actuators shall be equipped with a permanent manual adjustment.

d. Actuator shall fail-in-place.

e. Operating Voltage: 24 VAC.

f. Input Signal: 3 wire floating, 0 – 10 VDC, or 4 – 20 ma.

g. Spring Return Time: 20 seconds maximum.

h. For use when the maximum media temperature is 230° F.

i. Terminal Equipment includes

(i) Cabinet Unit Heaters

(ii) Fan Coil (AC) Units

(iii) Etc.

3. Damper Actuation

a. Damper actuators shall have external adjustable stops to limit the stroke in either direction.

b. All damper actuators shall have sufficient torque to overcome friction of damper linkage and air pressure acting on louvers and to operate the damper smoothly throughout the entire damper range.

c. Actuators shall be sized with a torque greater than 150% of the design damper torque.

d. Actuators shall have mounting arrangement for location outside of the air stream. The damper actuators shall be mounted on the damper extension so that it is not burned in the wall construction.

e. Damper actuators shall fail-safe in either the normally open or normally closed position in the event of power failure, signal failure or compressed air failure. Fail Safe Positions are as follows:

(i) Outside Air Dampers Normally Closed

(ii) Return Air Dampers Normally Opened

(iii) Exhaust Air Dampers Normally Closed

f. Provide one actuator per damper section. Where actuators do not have sufficient torque to operate damper section, either provide smaller damper sections to accommodate actuator torque or double torque master/slave damper actuators on the same shaft.

g. Electric Damper Actuation for Modulating and Two Position Dampers

(i) Proportional electronic, direct-coupled to either damper blade drive with no intermediate linkage or damper drive shaft; spring return

(ii) Actuator stroke by rotating motion (90º) of a reversible type synchronous motor with over load protection

(iii) Actuator shall be motor/drive in both the open and closed. (if spring return, drive to open and spring return closed).

(iv) Power input suitable for 120 Vac ±10 % or 24 Vac

(v) Proportional control damper actuators controlled from the BMS shall be designed to operate on a 4 to 20 mA or 0 to 10 Vdc and be compatible with either an analog or digital signal from the BMS

(vi) Two position control damper actuators controlled from the BMS shall be designed to operate on 24 Vac, 24 Vdc or 120 Vac single phase.

(vii) See Division 23; Section titled "Sequence of Operation for HVAC Controls for requirements for damper limit switches.

(viii) Operating Temperature Range; -40ºF to 140ºF

(ix) Actuator for terminal shall be in a plastic housing all other shall be in a die cast aluminum housing

(x) Actuator shall include permanent manual override, visual stroke indicators and built-in adjustable start and span controls

(xi) Manual drive release mechanism and manual positioning mechanism

(xii) Stroke time (full open to full closed)

(a) Two position damper; 60 to 90 seconds to drive open or closed 60 seconds spring return open or closed

(b) Proportional (modulating) Damper; 60 seconds to drive open, 15 seconds spring return closed)

(c) Smoke Control and Emergency Service; 15 to 30 seconds open or closed

2.7 DAMPER CONTRACTOR RESPONSIBILITY

A. Damper Responsibility Assignment

1. The following table summarizes the trade responsibilities with respect to automatic dampers (control):

	NON-FIRE OR SMOKE RELATED DAMPERS
Furnish Damper	Controls Contr.
Install Damper	Mech. Trade
Furnish Actuator(s)	Controls Contr.
Install Actuator(s)	Mech. Trade
Install and furnish terminal strip complete with all relays, wiring, etc.	Controls Contr.
Provide wiring between actuator, end switches, and terminal strip	Controls Contr.
Provide wiring from Central Control System (BMS) to damper terminal strip	Controls Contr.
Furnish 120V main power to elect. Actuators (See notes below)	Controls Contr.
Provide wiring from damper terminal strip to terminal strips for interlocked motors, etc.	Controls Contr.
Provide wiring from damper terminal strip directly to thermostats, etc.	Controls Contr.

NOTES

1. Controls contractor shall have overall responsibility for the complete coordination of the work and the operation of the damper/actuator installation.

2. In electric closets 120V power circuits will be provided from an emergency appliance panel. These circuits will be terminated in a junction box located in each electric closet and shall be used by the controls contractor to supply local control panels and critical equipment.

3. For dampers not requiring control by the fire alarm system and for other non-critical equipment, obtain power from the motor starter control circuit. All wiring shall be by the controls contractor.

B. Damper Terminal Strips

1. Terminal strip(s) shall be provided along side all motorized dampers. If the damper does not have a fire and/or smoke rating then the terminal strip shall be provided by the controls contractor.

2. Where dampers are furnished by the controls contractor then he shall provide relays, interconnect wiring and other components to meet the requirements detailed below. The terminal strip(s), relays, etc. shall be housed in wall mounted enclosures which meet the specifications detailed for local starter enclosures.

3. The terminal strip shall be wired such that the Central Control System (BMS) can undertake the following control and monitoring functions:

a. Open Control - A pair of terminals shall be wired such that when a controls (BMS) relay closes a contact pair across these terminals the damper is driven open. If the damper is two position with an actuator which drives closed and springs open on loss of power then these terminals shall not be used. Where dampers are interlocked to motors then the wiring shall be to these terminals.

b. Close Control - A pair of terminals shall be wired such that when a controls (BMS) relay closes a contact pair across these terminals the damper is driven closed. If the damper is two position with an actuator which drives open and springs closed on loss of power then these terminals shall not be used.

c. Motor Interlock - A pair of terminals shall be wired to an end switch on the actuator such that the contacts between the terminals shall be closed when the damper is fully open and open when the damper is not fully open. This pair of terminals shall be used for interlocking a damper with a motor such that the motor will not be able to start if the damper is not fully open

C. Damper Responsibility Assignment

1. The following summarizes the trade responsibilities with respect to automatic dampers (control):

a. Damper for HVAC Control Controlled by Building Management System (BMS) only;

(i) Damper furnished by Contractor responsible for the Building Management/Temperature Control System

(ii) Actuator furnished by Contractor responsible for the Building Management/Temperature Control System

(iii) Damper and Actuator installed HVAC Contractor

(iv) Wiring of Actuator by Contractor responsible for the Building Management/Temperature Control System

2.8 AUTOMATIC CONTROL DAMPERS

A. Automatic Temperature Control/Building Management System Manufacturer/Contractor shall furnish all control dampers and actuators as part of the work of this section.

B. HVAC Contractor shall install control dampers and actuators.

C. General

1. See previous subparagraphs titled Damper Responsibility Assignment for delineation of work associated with dampers.

2. Individual damper sections shall be limited to a maximum of 20.0 square feet. For damper with areas greater than 20.0 square feet, provide multiple section with total area as required.

3. Multiple section dampers shall have an actuator for each damper section.

4. Two position dampers shall be either parallel blade or opposed blade

5. Modulating dampers shall be oppose blade

6. Actuator shall be furnished as part of the work of this section for each automatic control damper. Provide actuator mountings brackets, drive arms, linkages and appurtenances as required for proper mounting of actuator. Where possible, actuators shall be factory mounted by damper manufacturer

7. Size actuators in accordance with manufacturers recommendation and industry standard

8. Install all actuators with complete access for maintenance and replacement. Installation of actuator within airstream will only be permitted where duct configuration do not allow for installation outside of airstream and written approval.

9. All dampers shall be installed by the mechanical contractor.

10. The BMS contractor shall furnish damper actuators for all dampers that he furnishes. Where practical, actuators shall be factory mounted by the damper manufacturer. The controls contractor shall provide a terminal strip alongside the damper for all dampers he furnishes.

11. The Mechanical contractor shall furnish damper actuators for all dampers that he furnishes. Where practical, actuators shall be factory mounted by the damper manufacturer. The mechanical contractor shall provide a terminal strip alongside the damper for all dampers he furnishes.

12. The controls contractor shall provide wiring as follows:

    a. Between the central control system BMS and the terminal strip for all dampers monitored and/or controlled by the BMS whether or not the controls contractor has furnished the damper.

    b. Between the terminal strip for all dampers and their associated thermostats, pressure switches, etc. whether or not the control contractor has furnished the damper.

13. Dampers incorporating multiple sections shall be controlled in unison. Where more than one (1) actuator serves a damper, then the actuators shall be driven in unison and the control wiring shall be provided accordingly.

14. Dampers incorporating multiple sections shall be designed in such a way that the actuators are easily accessible. Under no circumstances shall it be necessary to remove damper sections or structural or other fixtures to facilitate removal of damper motors. Provide access doors wherever necessary to meet this requirement. In particular, ensure that where in-air stream actuators are provided, they are readily accessible.

15. The BMS contractor shall provide all power and control wiring for all automatic dampers as required to accomplish the HVAC control sequences of operation. A portion of this work may also be specified in other areas of the specification. It is the responsibility of the BMS contractor to coordinate this work with the other trades. Any work not performed by others will be the ultimate responsibility of the BMS contractor. The fire alarm system shall be able to open or close each damper, regardless of BMS commands.

D. Two position automatic control damper

1. Frame

    a. 5 inches x minimum 16 gage roll formed galvanized sheet hat-shape channel

    b. Reinforced at corners

    c. Frame design strength shall be structurally equivalent to 13 gage channel

    d. Flange 1 ½ inch rolled formed at part of frame.

    e. Flange location front, rear or front and rear as required by project requirements.

    f. Flange shall be T flange construction minimum 6 inches x 1 3/8 inches with bolted corners where project conditions have damper installed in “Duct-mate” type systems.

2. Blades

   a. Action; Parallel

   b. Style: Single skin with minimum 3 full length longitudinal grooves

   c. Material; 6 gage galvanized steel equivalent thickness

   d. Blade Width; Nominal 6 inches

   e. Blade Length; Blade length shall limited to deflection of less than 1/180 of blade span at system design static pressure but in no case greater than 60 inches.

   f. Blade Orientation; Horizontal. If because project conditions dictate. vertical blades with thrust washers

3. Bearings; Molded synthetic sleeve turning in extruded hole in frame

4. Blade Seals

   a. Material; Neoprene, vinyl, polyurethane, silicone rubber, synthetic elastomer or PVC coated fiberglass material per manufacturers standard construction to meet leakage rate listed below

   b. Mechanical locked to blade edge.

   c. Field replaceable design

   d. Adhesive or clip-on type blade seals not acceptable

   e. Temperature Operating Range; -25ºF to 180ºF

5. Jamb Seal

   a. Flexible stainless steel; compression type

   b. Blade end overlapping frame for jam seal not acceptable

   c. Adhesive or clip-on type Jamb seals not acceptable

   d. Temperature Operating Range; -25ºF to 180ºF

6. Axles; Minimum ½ inch diameter plated steel; hexagonal-shape mechanically attached to blades

7. Linkage; Concealed in frame. Linkage in air stream not permitted

8. Damper Position; Two position indicator switches linked directly to damper blades to remotely indicate damper position.

9. Performance Criteria

   a. Damper performance and ratings tested and certified in accordance with AMCA Publication 500 for maximum air flow and maximum pressure rating.

   b. Comply with the requirements of the AMCA Certified Rating Program

   c. Leakage; Not to exceed 8 CFM per sq. ft. @ 4 inches static pressure

   d. Pressure Drop; Maximum 0.07 inches w.g. @ 1,500 FPM across a 24 inch x 24 inch damper section

10. Multiple Damper Configuration; Where cross-section area of damper requires multiple damper section, HVAC Contractor shall provide reinforcement and bracing as required to hold against maximum system static pressures

E. Modulating Dampers

1. General; Damper shall be designed for linear flow (proportional) characteristics from closed to 100% open and 100% open to closed.

2. Frame Construction

   a. 5 x 1 inches x 0.125 minimum wall thickness extruded aluminum hat channel

   b. Hat mounting flanges on both sides of frame or "T" flange for installation in "Duct-mate" type systems as required by project requirements.

   c. Corners reinforced with two die formed internal braces

   d. Flange location front, rear or front and rear as required by project requirements.

3. Blade Design

   a. Action; Opposed

   b. Style: Airfoil shape

   c. Extruded aluminum with internal structural reinforcing tube running full length of blade

   d. Blade Width; Nominal 6 inches

   e. Blade Length; Blade length shall limited to deflection of less than 1/180 of blade span at system design static pressure but in no case greater than 60 inches.

   f. Blade Orientation; Horizontal. If project conditions dictate. vertical blades with thrust washers

   g. Maximum single section size 48 inches wide x 60 inches high

4. Bearings;Non-corrosive molded synthetic

5. Blade Edge Seals

   a. Extruded double edge design

   b. Inflatable pocket design to enable air pressure from either direction to assist in blade seal –off

   c. Seals mechanically locked into extruded blade slots

   d. Field replaceable design

   e. Adhesive or clip-on type blade seals not acceptable

6. Jamb Seal

   a. Flexible metal compressible type

7. Axles; Minimum ½ inch diameter plated steel; hexagonal-shape mechanically attached to blades Round axles not acceptable

8. Linkage; Concealed in frame. Linage in air stream not permitted

9. Performance Criteria;

   a. Damper performance and ratings tested and certified in accordance with AMCA Publication 500 for maximum air flow and maximum pressure rating.

   b. Comply with the requirements of the AMCA Certified Rating Program.

   c. Damper shall be tested and licensed in accordance with AMCA 511 for Air Performance and Air Leakage

   d. Damper shall be tested and licensed in accordance with ASHRAE RP1157 for linear flow.

   e. Temperature Rating: -22°F to 122°F

   f. Leakage; Not to exceed 8 CFM per sq. ft. @ 4 inches w.g. static pressure and a maximum 3 CFM per sq. ft. @1 inch w.g.

   g. Pressure Drop; Maximum 0.07 inches w.g. @ 1,500 FPM across a 24 inch x 24 inch damper section

10. Multiple Damper Configuration; Where cross-section area of damper requires multiple damper section, HVAC Contractor shall provide reinforcement and bracing as required to hold against maximum system static pressures

2.9 CONTROL PANELS

A. Field Equipment Cabinets

1. All DDC controllers, transformers, electric relays, static pressure sensors, velocity pressure sensors, manual override switches, etc., shall be mounted in an appropriate NEMA enclosure and factory wired to terminal strips. The enclosure shall be constructed of steel or extruded aluminum and shall be properly rated for the location. Securely mount the enclosures to the wall or floor of the building structure using approved bracing adjacent to each system to be controlled.

2. Cabinets shall allow extra space for installation of future control components.

3. Submit for approval all proposed locations of DDC control and accessory panels.

4. Submit for approval dimensioned shop drawings of the panel equipment layout prior to panel fabrication.

5. Properly label all panel components including wiring and tubing.

2.10 NON BMS DEVICES

A. Non-BMS Monitored Devices

1. Electric Thermostats

a. Furnish and install all electric thermostats for local control of miscellaneous equipment (unit heater, cabinet heater, baseboard heater, etc.) that use on/off control. Thermostat contacts shall be rated for maximum heater amperage and shall be snap acting, SPDT.

b. Space thermostat shall have:

(i) Concealed set point adjustment with a range of 55 -85 deg. F.

(ii) Concealed thermometer temperature indication

(iii) Heat-off-cool switch (if applicable)

(iv) Fan speed switch (2 or 3) (if applicable)

c. Voltage; Line voltage for equipment rated at 120 volts or for equipment rated at greater than 120 volts, coordinate with approved equipment for transformed voltage.

PART 3 - EXECUTION

3.1 DESIGN CRITERIA

A. The Building Management System (BMS) shall be programmed to start and stop the HVAC equipment based on occupancy schedules as coordinated with the owner. The BMS shall also provide equipment interlocks as required.

B. Each preheat coil section shall be provided with a separate sensor, control loop, output signal, and freezestat.

C. All control dampers that are sequenced shall be provided with dedicated analog outputs or positioning relays, as applicable.

D. Fire Alarm Interface for Fans

1. The Fire Alarm System shall provide outputs to notify the BMS of fire alarms.

2. All fan systems shall be stopped from the FAS. When the fan system stops, all associated dampers shall close.

3. All return and exhaust fans shall be stopped from the FAS. When the fan stops, all associated dampers shall close.

E. All safeties shall be capable of being remotely reset from the BMS.

F. All setpoints shall be adjustable from any BMS personal computer operator workstation via single point commands.

G. All reset schedule parameters shall be adjustable from any BMS personal computer operator workstation via single point commands.

H. All inputs and outputs shall be provided with programmable (adjustable) high and low software alarm limits.

3.2 INSTALLATION CRITERIA

A. Space mounted devices are to be identical in appearance. All devices shall be mounted under the same style cover.

B. Room sensors and thermostats shall not be located on outside walls.

C. Provide all relays, switches, sources of electricity and all other auxiliaries, accessories and connections necessary to make a complete operable system in accordance with the sequences specified.

D. Install controls so that adjustments and calibrations can be readily made. Controls are to be installed by the control equipment manufacturer.

E. Mount surface-mounted control devices, tubing and raceways on brackets to clear the final finished surface on insulation.

F. Conceal control conduit and wiring in all spaces except in the Mechanical Equipment Rooms and in unfinished spaces. Install in parallel banks with all changes in directions made at 90 degree angles.

G. Unless otherwise noted, install wall-mounted sensors, thermostats and humidistats to meet American Disability Act (ADA), Fair Housing Act (FHA) or other local, State or Federal having jurisdiction requirements. Submit device samples, locations, mounting heights and details for approval for all devices.

H. Install outdoor thermostats in perforated tube and sun shield.

I. All relays, electrical wiring, panels, outputs, etc. to make a complete operational system, shall be provided and installed by this section. See sequences of operation for details.

J. Component Tags

1. All sensors shall be identified with 1"x 3" black labels with white lettering. Lettering shall be 1/4" high. Provide sensor number, HVAC Unit number, part number and sensor range on tag. Submit tag schedule and sample for approval.

2. All panels, auxiliary component panels, transformer panels, etc. provided by this contractor, shall be identified with 2"x 5" black lamacoid labels with engraved white lettering. Lettering shall be ½" high. Provide panel number, HVAC unit number and service on tag. Submit tag schedule and sample for approval.

3.3 ELECTRICAL WIRING

A. The BMS Contractor shall be responsible for all electrical control work associated with the BMS, HVAC and plumbing systems which is not specified as work of others.

1. Perform all wiring in accordance with all local and national codes including the NEC.

2. Install all line voltage wiring, concealed or exposed, in conduit in accordance with the Division 26 specifications, NEC and local building code.

3. All low voltage electrical control wiring and all Primary Network wiring throughout the building shall be run in conduit. Terminal equipment sensors and the secondary network wiring may be run in plenum rated cable above accessible hung ceilings. Plenum cable shall be run parallel to building lines and supported from the building structure (not from duct, pipe or associated hangers) with bridle rings.

4. Provide extension of 120 volt, 20 amp circuits and circuit breakers from emergency power panels and or electrical junction boxes for entire system, except terminal equipment, as required.

5. Surge transient protection shall be incorporated in the design of system to protect electrical components in all DDC control panels and operator workstations.

6. Provide all miscellaneous field device mounting and interconnecting control wiring for all mechanical systems including but not limited to the fuel oil system, emergency generators, AC units, condensing units, PIMs, ECMs, unit heaters, electric heaters, cabinet heaters, domestic water system, and plumbing systems.

7. All systems requiring interconnecting control wiring as specified herein, shall have hardwired interlocks and shall not rely on the BMS to operate. Interconnecting wiring shall be run in conduits separate from the BMS associated wiring.

8. All wiring for network communication, sensor signals and interlock wiring shall be permanently labeled at a minimum of 10-foot intervals. Label shall indicate BMS manufacturer's name and cable usage. Labels shall be securely fastened and not be damaged during installation. Cable jackets shall also be color coded to indicate application.

9. Cables shall be tagged or labeled at each termination point and in each intermediate junction box, pull box or cabinet through which they pass.

10. All control and power wiring associated with the control of all automatic dampers shall be installed in conduit, regardless of voltage. All control and power wiring for relays associated with the control of any automatic damper shall be installed in conduit, regardless of voltage.

11. Data communication between separate buildings or facilities shall be via fiber optic cable only.

12. Provide all line and low voltage wiring for the control of all HVAC motors (whether individual or as part of packaged equipment) and dampers, including wiring for EP's, PE's, relays, control panels, unit heater and cabinet heater control, etc., except as noted below.

    a. A separate system of wiring, for smoke and fire control of motors which are to be automatically and/or manually controlled by the fire protective alarm (FPA) system will be run to the motor starters or SCU enclosures by the electrical trade.

13. The BMS contractor shall provide wiring:

    a. Between thermostats, aquastats and unit heater motors.

    b. All control and alarm wiring for all control and alarm devices for all Sections of Specifications.

    c. 120 volt, single phase, 60 hertz emergency power to every BMS panel, , BMS console, PIM, CRT, CPU, , annunciator modules, modems, intercom modules, printers and to other devices as required. It is the intent that the entire building management system and all peripheral devices, alarms, etc., shall be operative under emergency power conditions in the building. The power supplies are to be extended in conduit and wire from emergency circuit breakers.

    d. Provide power supply wiring (as required) to all dampers which do not require "direct" (i.e., not in response to motor operation) smoke and fire control by the fire protective alarm (FPA) system.

e. Provide status function conduit and wiring for equipment covered under this section.

f. Provide conduit and wiring between the BMS panels and the temperature, humidity, or pressure sensing elements, including low voltage control wiring.

g. Provide conduit and control wiring for devices specified in this Section.

h. Provide conduit and signal wiring between motor starters in motor control centers and high and/or low temperature relay contacts and remote relays in BMS panels located in the vicinity of motor control centers.

i. Provide conduit and wiring between the PC workstation, electrical panels, metering instrumentation, indicating devices, miscellaneous alarm points, remotely operated contractors, and BMS panels, as shown on the drawings or as specified.

j. Provide electrical wall box and conduit sleeve for all wall mounted devices.

k. Where conduit is required, it shall be steel electric metallic tubing (EMT), except that it shall be galvanized intermediate steel conduit where located within 8'-0" of the floor in mechanical spaces (or is otherwise exposed to mechanical damage), or is intended for embodiment in concrete.

14. Wires and cables shall have characteristics - in compliance with Articles 725 and/or 800 (as applicable) of the National Electrical Code - as described elsewhere in the specifications or drawings for this project and shall be UL listed in accordance therewith.

15. Where wires and cables are permitted to be run without conduit, they shall be independently supported from the building structure or ceiling suspension systems at intervals not exceeding four feet on center, utilizing cable supports specifically approved for the purpose. Wires and cables shall not rest on or depend on support from suspended ceiling media (tiles, lath, plaster, as well as splines, runners or bars in the plane of the ceiling), nor shall they be supported from pipes, ducts or conduits. Where cables are bundled together, separate bundles shall be provided separately for each type of cabling and separately for each independent system. Bundling and/or supporting ties shall be of a type suitable for use in a ceiling air handling plenum regardless of whether or not installed in a plenum.

16. Utilize #14 A.W.G. THWN conductors minimum throughout for power wiring (120 VAC or greater) except in conjunction with a manual starter. For a manual starter, utilize conductors equal in size to those in the power circuit.

17. Motor control circuit wires may be run in the same conduit as the wires of motor power circuits; however, abide by the following:

a. Exclude motor control wires from enclosures (other than motor starter enclosures) which contain power circuit overcurrent protection and switching devices;

b. Exclude motor control wires from pull boxes and junction boxes containing the wires of main and submain feeders.

c. Utilize auxiliary pull boxes to separate motor control wires from motor power circuit wires at a point before the power circuit wires enter the items from which motor control wires are excluded.

d. Exclude motor control wires from the same conduits as motor power circuit wires larger than 250 MCM.

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

19. Utilize copper conductors with THWN, THHN or XHHW insulation. Type THHW and THHW-2 shall not be utilized where excluded by conduit sizing. Type THWN shall not be utilized for connection to 100% rated overcurrent devices.

20. Pull conductors into raceway simultaneously where more than one is being installed in same raceway.

21. Use pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation.

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

23. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

24. Properly ground all field equipment panels and terminal unit equipment.

3.4 COORDINATION

A. Coordination with Other Trades

1. Piping and duct installation requirements are specified in other Division 23 Sections. Coordinate installation of all devices furnished under this section to be installed by other trades with the appropriate trade.

2. It is the responsibility of this contractor to coordinate with all trades the location of installed equipment and routing of all electrical control conduits and lines.

3. Install control system components to allow for proper service and maintenance of equipment.

B. Work Performance Schedule

1. A time-phased schedule for delivery, installation, and acceptance of components for the complete system shall be prepared. Submit this schedule to the Owner within five (5) days after award of contract. Submit updates and changes to this schedule promptly to the Owner.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

B. Commissioning, Testing and Acceptance

1. Perform a three-phase commissioning procedure consisting of field I/O calibration and commissioning, system commissioning and integrated system program commissioning. Document all commissioning information on commissioning data sheets that shall be submitted prior to acceptance testing. Commissioning work that requires shutdown of system or deviation from normal function shall be performed when the operation of the system is not required. The commissioning must be coordinated with the owner and construction manager to ensure systems are available when needed. Notify the operating personal in writing of the testing schedule so that authorized personnel from the owner and construction manager are present throughout the commissioning procedure.

2. Phase I – Field I/O Calibration and Commissioning

a. Verify that each control panel has been installed according to plans, specifications and approved shop drawings. Calibrate, test, and have signed off each control sensor and device. Commissioning to include, but not be limited to:

(i) Sensor accuracy at 10, 50 and 90% of range.

(ii) Sensor range.

(iii) Verify analog limit and binary alarm reporting.

(iv) Point value reporting.

(v) Binary alarm and switch settings.

(vi) Fail safe operation on loss of control signal, electric power, network communications, etc.

3. Phase II – System Commissioning

a. Each BMS program shall be put on line and commissioned. The contractor shall, in the presence of the owner and construction manager, demonstrate each programmed sequence of operation and compare the results in writing. In addition, each control loop shall be tested to verify proper response and stable control, within specified accuracy. System program test results shall be recorded on commissioning data sheets and submitted for record. Any discrepancies between the specification and the actual performance will be immediately rectified and re-tested.

4. Phase III - Integrated System Program Commissioning

a. Tests shall include, but not be limited to:

(i) Data communication, both normal and failure modes.

(ii) Fully loaded system response time.

(iii) Impact of component failures on system performance and system operation.

(iv) Time/Date changes.

(v) End of month/ end of year operation.

(vi) Season changeover.

(vii) Global application programs and point sharing.

(viii) System backup and reloading.

(ix) System status displays.

(x) Diagnostic functions.

(xi) Power failure routines.

(xii) Battery backup.

(xiii) Smoke Control in concert with Fire Alarm System testing.

(xiv) Testing of all electrical and HVAC systems with other division of work.

b. Test procedure and documentation shall be as follows:

(i) Submit for approval, a detailed acceptance test procedure designed to demonstrate compliance with contractual requirements. This Acceptance test procedure will take place after the commissioning procedure but before final acceptance, to verify that sensors and control devices maintain specified accuracy and the system performance does not degrade over time.

(ii) Using the commissioning test data sheets, the contractor shall demonstrate each point. The contractor shall also demonstrate 100 percent of the system functions. The contractor shall demonstrate all points and system functions until all devices and functions meet specification.

(iii) The BMS contractor shall supply all instruments for testing. Instruments shall be turned over to the owner after acceptance testing.

(iv) All test instruments shall be submitted for approval prior to their use in commissioning.

(v) Test Instrument Accuracy:

(a) Temperature: 1/4F or 1/2% full scale, whichever is less.

(b) High Pressure (PSI): ½ PSI or 1/2% full scale, whichever is less.

(c) Low Pressure: 1/2% of full scale (in w.c.)

(d) Humidity: 2% RH

(e) Electrical: 1/4% full scale

(vi) After the above tests are complete and the system is demonstrated to be functioning as specified, a thirty-day performance test period shall begin. If the system performs as specified throughout the test period, requiring only routine maintenance, the system shall be accepted. If the system fails during the test, and cannot be fully corrected within eight hours, the owner may request that performance tests be repeated.

c. Sub Systems shall also be tested and commissioned.

5. Move In Checkout

a. Each floor shall be re-tested 24 hours prior to move in. The test shall ensure all corrective work is complete and all systems are 100% operational.

6. Additional testing, debugging and fine tuning

a. Provide an additional 100 overtime hours of appropriate highest labor cost category to be used at the owner's discretion to test, debug and fine tune the system after occupancy.

C. Owner System Performance Verification (OSPV) (If required)

1. The systems and equipment shall be fully functional and operational prior to the OSPV process, or the contract(s) will be back-charged accordingly.

2. OSPV is the process in which the contractor fully demonstrates system operation, system performance, proper operation of the sequence of operations, and system equipment to the Owner's operating staff in the presence of an OSPV agent.

3. After the contractor's obligations are completed, including system testing, equipment testing, calibration, system demonstration, sequence of operation start-up, training, providing of maintenance and operation manuals, and corrective action for all punchlist items, the OSPV process begins. The BMS Contractor shall include in their bid the number of hours and the number of technicians required for the OSPV process but in no case less than 80 hours and two technicians.

4. Complementary to the BMS contractor's responsibility to commission the building systems, an OSPV agent will be retained by the Owner. This OSPV agent will provide independent equipment-systems installation inspection and performance verification. The independent verification will be requested prior to final equipment and systems acceptance by the Owner. It should be emphasized that independent systems verification prior to the OSPV process does not negate the BMS contractor's obligations to full commission the control system.

5. The OSPV agent will verify system installation, operation, performance, and sequences of operation after the BMS contractor provides written notice that the building system is completed, tested, and fully operational. Upon this notification, the OSPV agent will perform the initial verification. The OSPV agent will provide one (1) additional installation and performance verification, upon notification by the BMS contractor that deficiencies identified have been corrected. Any subsequent installation and performance verification will be at the BMS contractor's expense.

6. All building systems shall be verified under actual and simulated full load conditions.

7. The Owner, Architect, Engineer, and OSPV agent will have input to and be part of the approval process for systems performance verification.

8. The Owner's staff shall be informed of all system start-up, shutdown, and verification procedures that involve any utility usage or interruption.

9. The BMS contractor's technicians provided for the OSPV process shall be thoroughly familiar with the OSPV process (start-up, sequence of operation, shutdown, etc.) and the system or equipment required for the OSPV work. The personnel must also be thoroughly familiar with the project specifications and drawings. Convenient technician substitutes for the OSPV process are unacceptable.

10. Under OSPV, the following shall be verified:

    a. Point to point verification of all BMS points.

    b. The sequence of operation for all systems and equipment.

    c. Calibration of all inputs and outputs.

    d. Operation of the compressed air plant.

    e. System programming.

    f. Standard operation procedures (SOP).

11. The OSPV process includes but is not limited to the above items.

3.6 DEMONSTRATION

A. Maintenance Data and Operating Instructions

1. Description - Maintenance and operating manuals in accordance with Division 01; titled "General Requirements".

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

2. Manual for Equipment and Systems

    a. Each item of equipment and each system: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and test, and complete nomenclature and model number of replaceable parts.

    b. Panelboard Circuit Directories: provide electrical service characteristics, controls, and communications.

    c. Include wiring diagrams as installed.

    d. Operating Procedures: Includes start-up, break-in and routine normal operating instructions and sequences. Include regulation, control stopping, shutdown and emergency instructions. Include summer, winter, and any other special operating instructions.

    e. Maintenance Requirements: Include routine procedures and guide for preventative maintenance, trouble shooting; disassembly repair, re-assembly instructions including alignment, adjusting, balancing, and checking instructions.

    f. Provide servicing and lubrication schedule for dampers and actuators. Provide a list of lubricants required.

    g. Include manufacturers printed operation and maintenance instructions.

    h. Include sequence of operation by controls manufacturer.

    i. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams.

    j. Provide control diagrams by controls manufacturer as installed.

    k. Provide contractor's coordination drawings with control piping diagrams as installed.

    l. Provide list of original manufacturer's spare parts. Provide a recommendation of quantities to be maintained in storage.

    m. Provide additional requirements as specified in individual product specification sections.

3. Instruction of Facility Personnel

a. Before final inspection, instruct Owner's designated personnel in operation, adjustment and maintenance of products, equipment, and systems, at agreed upon times.

b. For equipment requiring seasonal operation, perform instruction for other seasons within six months.

c. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

d. Prepare and insert additional data in Operation and Maintenance manual when need for such data becomes apparent during instruction.

4. After all final tests and adjustments have been completed, fully instruct the proper Owner's Representative in all details of operation for equipment installed. Supply qualified personnel to operate equipment for sufficient length of time to assure that Owner's Representative is properly qualified to take over operation and maintenance procedures. Supply qualified personnel to operate equipment for sufficient length of time as required to meet all governing authorities in operation and performance tests.

B. Display of Maintenance Instructions

1. One set of operating and maintenance instructions shall be neatly framed behind glass and hung adjacent to the equipment concerned.

C. Training

1. The Contractor shall provide competent instructors to give full instruction to designated personnel in the adjustment, operation and maintenance of the system installed rather than a general training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. All training shall be held during normal work hours of 8:00 a.m. to 4:30 p.m. weekdays.

2. Provide eighty (80) hours of training for Owner's operating and maintenance personnel. 40 hours shall be off site classroom training and 40 hours shall be on-site training. Videotape all sessions and edit each session to 1-hour tapes. Turn over two copies each unedited and edited tape to the Owner. Training shall include:

a. Explanation of drawings, operator's and maintenance manuals.

b. Walk-through of the job to locate all control components.

c. Operator workstation and peripherals.

d. DDC Controller and ASC operation/function.

e. Operator control functions including graphic generation, if design includes color graphics, and field panel programming.

f. Operation of portable operator's terminal, if an operator terminal is provided to the owner as per this specification.

g. Explanation of adjustment, calibration and replacement procedures.

3. Provide 8 hours of additional training quarterly during warranty period.

4. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If the Owner requires such training, it will be contracted at a later date. Provide description of available local and factory customer training. Provide costs associated with performing training at an off-site classroom facility and detail what is included in the manufacturer's standard pricing such as transportation, meals, etc.

3.7 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested by the Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

END OF SECTION 23 09 00

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SECTION 23 09 10 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. All set points referenced in this section are subject to change and shall be adjustable from the BMS Operator Workstation and from a Portable Operators Terminal.

C. Related Sections include the following:

1. Division 23 Section "HVAC Instrumentation and Controls" for control equipment and devices and submittal requirements.

2. Applicable Sections of Division 23 for equipment provided with factory mounted controls that interface with the Building Management System (BMS) provided as part of this Section.

3. Applicable Sections of Division 21, 22 & 26 for equipment provided with factory mounted controls that interface with the Building Management System (BMS) provided as part of this Section

1.3 DEFINITIONS

A. AI - Analog Input

B. ANSI - American National Standards Institute

C. AO - Analog Output

D. ASCII - American Standard Code for Information Interchange

E. AWG - American Wire Gauge

F. BMS - Building Management System

G. CPU - Central Processing Unit

H. CRT - Cathode Ray Tube

I. DAC - Digital to Analog Converter

J. DDC - Direct Digital Control

K. DI - Digital Input

L.	DO	-	Digital Output
M.	EEPROM	-	Electronically Erasable Programmable Read Only Memory
N.	EMI	-	Electromagnetic Interference
O.	FAS	-	Fire Alarm Detection and Annunciation System
P.	HOA	-	Hand-Off-Auto
Q.	IEEE	-	Institute of Electrical and Electronics Engineers
R.	I/O	-	Input/Output
S.	LAN	-	Local Area Network
T.	LCD	-	Liquid Crystal Display
U.	LED	-	Light Emitting Diode
V.	MCC	-	Motor Control Center
W.	NC	-	Normally Closed
X.	NO	-	Normally Open
Y.	OWS	-	Operator Workstation
Z.	OAT	-	Outdoor Air Temperature
AA.	PC	-	Personal Computer
BB.	RAM	-	Random Access Memory
CC.	RFI	-	Radio Frequency Interference
DD.	RH	-	Relative Humidity
EE.	ROM	-	Read Only Memory
FF.	RTD	-	Resistance Temperature Detector
GG.	TCP/IP	-	Transmission Control Protocol/Internet Protocol
HH.	UPS	-	Uninterruptible Power Supply
II.	VAC	-	Volts, Alternating Current
JJ.	VDC	-	Volts, Direct Current
KK.	WAN	-	Wide Area Network .

1.4 BMS INTERFACE TO PACKAGED ROOFTOP AIR HANDLING UNITS (899-DOAS-R-01 & 899-DOAS-R-02)

A. General:

1. Service:

a. The DOAS unit shall be controlled by a DDC controller furnished, installed, and wired by the air handling unit manufacturer.

b. The BMS Contractor shall furnish a software interface to the air handling unit controller which shall monitor and control the points outlined on the input/output point summary, as shown on drawing M-705.

c. The BMS contractor shall furnish, install, and wire all devices necessary for complete operation of the air handling unit including space thermostats, etc.. The BMS contractor shall furnish, install, and wire the communications bus for the AC DDC controllers.

d. The BMS contractor shall furnish, install, and wire all devices needed in addition to those specified to control the air handling unit for setback and setup operation during unoccupied mode as well as warm-up and cool-down modes.

2. System Off:

a. Supply and Return Fan: Off.

b. Outside Air Damper: Closed.

c. DX Cooling: Off.

d. Electric Heat: Off - SCR to 0%.

3. System Start:

a. The air-handling unit shall be started based upon a start time optimization program, time of day schedule, or manual command.

b. When the air-handling unit is indexed to operate, all dampers shall open. Where required, hard-wired damper end switches shall prove damper status prior to fan start.

c. The return fan shall start first. Following a 5-second delay, the supply fan shall start.

4. System Run:

a. Occupied Mode:

(i) Supply and Return Fan: Supply and Return fan shall run continuously.

(ii) DX Cooling: Modulate in sequence with hot gas bypass to maintain the discharge air temperature at setpoint as reset by space temperature.

(iii) Electric Heat: Modulate SCR in sequence with the DX cooling to maintain the discharge air temperature setpoint when the supply fan is on.

(iv) Operate at a 50% setback during unoccupied periods in conjunction with exhaust fans

5. System Stop:

a. When the air-handling unit is indexed to shut down, the supply and return fan shall stop.

b. Dampers and electric heat shall be indexed to their 'System Off' conditions.

6. Safeties And Alarms:

a. Reset / Restart: Any safety shutdown shall allow for local manual reset and restart from the BMS system.

b. High Static: High discharge pressure switches shall stop the supply and return fans when duct pressure exceeds design and annunciate an alarm. Dampers shall be indexed to their 'System Off' conditions. The fans shall remain off until the pressure switch is manually reset.

c. Filter Condition: Monitor differential pressures across filter and annunciate alarm when differential pressure set point is exceeded.

d. Emergency Shutdown:

(i) Duct smoke detector(s) shall stop the supply and return fans and annunciate an alarm when products of combustion are detected in the air stream. The duct smoke detectors shall be wired into the building fire alarm system.

(ii) The supply and return fans shall be interlocked to shut down upon a command from the building fire alarm system.

e. Annunciate off alarms whenever supply or return fan status does not equal start command.

7. Failure Modes:

a. Fan Failure: If the supply or return fan fails to operate, both fans shall shut down and alarm shall be annunciated. Dampers shall be indexed to their 'System Off' conditions.

b. Sensor Failure: Upon the failure of an analog sensor, associated dampers and control valves shall remain at their last position and alarm shall be annunciated.

c. Power Failure:

(i) Upon a power failure, the equipment that is scheduled to operate under emergency power shall be enabled.

(ii) Upon restoration of normal power, the equipment that is scheduled to run under normal power shall be enabled in a staggered fashion.

8. Unoccupied mode:

a. During unoccupied hours, only one (1) of the two (2) DOAS units will operate in a lead/lag fashion to reduced runtime on the units. This sequence will allow partial ventilation of spaces during unoccupied hours.

b. During this sequence, the supply duct's normally closed automated damper that joins the two DOAS systems will be commanded open to allow air from one (1) DOAS to service both ducted system areas.

1.5 VRF AC Unit

A. Service:

1. Indoor Evaporator Units: 899-CU-R-01 THROUGH 899-CU-R-05

2. Air-Cooled Condensing Unit: 899-AC-1-01A THROUGH 899-AC-1-01G, 899-AC-1-02A THROUGH 899-AC-1-02G, 899-AC-1-03A THROUGH 899-AC-1-03E, 899-AC-1-04A THROUGH 899-AC-1-04G, 899-AC-1-05A THROUGH 899-AC-1-05F

B. The air conditioning units shall be furnished with local controls for stand-alone operation.

C. The BMS Contractor shall provide all required field wiring of controls that cannot be factory installed for proper AC unit operation including space thermostats, communication bus, heat recovery box, branch circuit box and remote condensing unit interlock wiring.

D. The BMS contractor shall furnish a BACnet serial interface to connect the AC unit master control module to the BMS. The AC unit manufacturer shall provide a master control module communication card. The BMS contractor shall provide an interface and all programming to monitor and control all points from the AC units to the BMS.

E. For ceiling mounted units, the BMS contractor shall furnish and install a leak detector that shall be located in the unit's drip pan. The BMS shall also monitor the condensate pump high level float switch and when water is detected in the pan of the high level float switch closes, the AC shall shut down and an alarm shall be annunciated to the BMS. The unit shall remain off until the high-water condition has been corrected.

F. Coordinate control of electric mats through the BMS per drawing M-705..

G. DDC Points:

1. All AC Unit Points via BACnet Network Interface as noted on drawing M-705.

2. Condensate High Level/Drip Pan Water Leak Detection Alarm

H. VRF AC Unit Serving Electrical Room and TELE/DATA room

1. Service:

a. Indoor Evaporator Units: 899-AC-1-06, 899-AC-1-06,

b. Air-Cooled Condensing Unit: 899-CU-1-06, 899-CU-1-07,

2. The air conditioning units shall be furnished with local controls for stand-alone operation.

3. The BMS Contractor shall provide all required field wiring of controls that cannot be factory installed for proper AC unit operation including space thermostats, communication bus, and remote condensing unit interlock wiring.

4. The BMS contractor shall furnish a BACnet serial interface to connect the AC unit master control module to the BMS. The AC unit manufacturer shall provide a master control module communication card. The BMS contractor shall provide an interface and all programming to monitor and control all points from the AC units to the BMS.

5. The BMS shall monitor the condensate pump high level float switch and when water is detected, the AC shall shut down and an alarm shall be annunciated to the BMS. The unit shall remain off until the high-water condition has been corrected.

6. For the Tele/data room and Electrical Room provide an independent temperature sensor to monitor the space temperature and annunciate an alarm to the BMS if the high alarm limit temperature is reached.

7. DDC Points:

a. All AC Unit Points via BACnet Network Interface per drawings M-704 and M-705

b. Condensate High Level/Drip Pan Water Leak Detection Alarm

c. Space Temperature w/ High/Low Alarm

1.6 ELECTRIC RADIANT MATS

A. Refer to drawings M-150, M-502, M-705 and coordinate with electrical drawings. The BMS Contractor shall provide all required field wiring of controls.

B. Electric mats to maintain a set floor temperature through the BMS based upon a time of day schedule.

C. Operation of electric mats to be locked out by the BMS when the room AC unit(s) is(are) in cooling.

D. Combination space temperature and CO2 sensor is tied into BMS DDC panel. Radiant floor heat is enabled/disabled via BMS based on outside air temperature below 55 deg_F (adjustable). When enabled, the radiant floor heat sensor shall maintain floor temperature at setpoint, 85 deg_F (adjustable), via manufacturer furnished temperature sensor(s).

1.7 GENERAL EXHAUST FAN LESS THAN 2000 CFM: 899-TXF-R-01, 899-TXF-R-02, 899-GXF-R-01

A. General:

1. Service: See mechanical equipment schedule.

B. System Off:

1. Exhaust Fan: Off.

2. Damper: Fully closed.

C. System Start:

1. Exhaust Fan: The fan shall be started through the BMS based upon a start time optimization program, time of day schedule, or manual command.

2. Damper: When the fan is indexed to operate, all exhaust air dampers shall open. Where required, hard-wired damper end switches shall prove damper open status prior to fan start.

D. System Run:

1. Exhaust Fan: Fan shall run continuously.

2. Damper: Remain full open.

E. System Stop:

1. Exhaust Fan: When the fan is indexed to shut down, the exhaust fan shall stop.

2. Damper: Dampers shall be indexed to their ’System Off’ conditions.

F. Safeties And Alarms:

1. Reset / Restart: Any safety shutdown shall allow for local manual reset and restart from the BMS system.

G. Failure Modes:

1. Fan Failure: If the exhaust fan fails to operate an alarm shall be annunciated at the BMS. Dampers shall be indexed to their ’System Off‘ conditions.

2. Power Failure:

a. Upon a power failure, the equipment that is scheduled to operate under emergency power shall be enabled.

b. Upon restoration of normal power, the equipment that is scheduled to run under normal power shall be enabled in a staggered fashion.

3. Dampers: Exhaust dampers shall be provided with spring return actuators to fail to their 'System Off' positions.

1.8 EXHAUST FAN WITH SPACE TEMPERATURE CONTROL: 899-TF-1-01, 899-TF-1-02, 899-TF-1-03

A. General:

1. Service: See mechanical equipment schedule.

B. System Off:

1. Exhaust Fan: Off.

C. System Start:

1. Exhaust Fan: The fan shall be started whenever the space temperature rises above the space temperature setpoint of 80°F.

D. System Run:

1. Exhaust Fan: Fan shall run based on the space temperature sensor.

E. System Stop:

1. Exhaust Fan: When the temperature is at or below setpoint the fan shall stop.

F. Failure Modes:

1. Fan Failure: If the exhaust fan fails to operate an alarm shall be annunciated at the BMS.

2. Power Failure:

a. Upon a power failure, the equipment that is scheduled to operate under emergency power shall be enabled.

b. Upon restoration of normal power, the equipment that is scheduled to run under normal power shall be enabled in a staggered fashion.

1.9 MISCELLANEOUS SYSTEM CONTROL SEQUENCES

A. Electric Unit Heater: 899-EH-1-01, 899-EH-1-02

1. Electric Unit Heater Monitored by BMS

a. Alarm

(i) An alarm shall be annunciated on the BMS if the space temperature exceeds the high or low alarm limits.

b. A factory furnished thermostat on the unit shall control the temperature setpoint. The BMS contractor shall furnish, install, and wire a space temperature sensor to monitor space temperature. On a fall in space temperature an alarm shall be annunciated at the BMS.

c. The space temperature sensor and fan status shall be a BMS input. Fan status shall be monitored via a current sensing relay.

B. Equipment Restart Program

1. Subsequent to any building wide equipment shutdown, due to power failure, occupancy scheduling, priority lead shedding, etc., the mechanical equipment (with the exclusion of those supplied with emergency power) restarts shall be staggered and phased to minimize peak electrical loads. Time delays shall be adjustable and shall be provided for each controlled motor. The final restart sequence shall be submitted for approval.

2. All units shall be remotely reset and restarted from the BMS after a safety shutdown.

C. Air Filter (At all locations)

1. The BMS system shall monitor the actual differential pressure across each filter. An alarm shall be generated if the differential pressure exceeds design conditions.

D. Heat Trace

1. The BMS shall monitor a common alarm contact from each heat trace control panel.

2. The BMS shall override the heat trace system on and sound an alarm if outside air temperature falls below 40°F and the heat trace system has not activated.

E. Domestic Hot Water Heaters

1. The BMS contractor shall install and wire all devices supplied by the domestic hot water heater manufacturer. The BMS contractor shall furnish, install, and wire any devices not furnished by the domestic hot water heater manufacturer that are necessary for a completely operational domestic hot water heating system

2. The BMS shall monitor common alarm and supply water temperature. If an abnormal condition exists, an alarm shall sound at the BMS

F. Automatic Transfer Switches (Assoc Emergency Generator).

1. The BMS shall monitor the following points for each automatic transfer switch. Refer to electrical drawings for quantity and location.

a. Connected to normal.

b. Connected to emergency.

c. Normal source available.

d. Emergency source available.

e. Automatic transfer switch, to be provided with Modbus, in load shed.

f. Coordinate with electrical on shedding radiant heat and EV chargers. Coordinate any required time delays for generator.

G. System Integration

1. General

a. Furnish, install, and wire a communications interface between the BMS and the system to be integrated. Furnish, install, and wire all components necessary for a fully operational system interface.

b. Data transfer rate shall be sufficient to maintain data as current to within 15 seconds.

c. Provide one graphic page per floor for each foreign system.

d. The integration modules shall be coordinated, installed and started up prior to the start up and check out of the foreign system. All data shall be checked for accuracy on both sides of the serial interface during the foreign system commissioning process. Provide all labor as required.

2. Fire Alarm System, duct smoke detector to have extra relay and BMS to have a monitoring point.

3. Lighting Control System

4. Security System

H. Miscellaneous Point Monitoring

1. Provide interposing relays as required to monitor discrete digital inputs from equipment provided by others.

1.10 SPECIAL DESIGN CONSIDERATIONS

A. Miscellaneous Monitoring Points

1. Fire Alarm System

2. Water meters

3. Electrical meters

4. Carbon Dioxide sensors as located in plan.

B. Water Leak Detection General Alarm

1. As indicated on plans

PART 2 - PRODUCTS

(Not Applicable)

PART 3 - EXECUTION

(Not Applicable)

END OF SECTION 23 09 10

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SECTION 23 21 13 - HYDRONIC PIPING

PART 1 - PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Condensate-drain piping.

B. Related Sections include the following:

1. Applicable Sections of Division 23.

1.3 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Condensate drain piping

a. 150 psig: 200˚F

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Pressure-seal fittings.

2. Piping Specification.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: Detail, at 1/8 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Welding certificates. (See Part 3)

C. Field quality-control test reports. (See Part 3)

D. Coordination drawings as outlined in Division 23; Section titled “Basic Mechanical Requirements.”

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. All pipe shall be manufactured in the United States. If the HVAC Contractor elects to purchase piping outside of the United States, the HVAC Contractor, prior to the purchase of the pipe, shall submit complete certifications and typical mill reports in English for review. Pipe purchase outside of the United States and delivered to the project site shall bear identification and mill heat markings and corresponding mill test reports shall be made available.

B. Mill certifications from the pipe supplier shall be made available upon request by the Owner or Engineer.

C. Piping found to be in violation of this specification maybe required to be removed and replace from the project whether or not already installed.

D. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

E. See Welding procedure requirements in Part 3 of this specification.

F. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Wrought-Copper Fittings: ASME B16.22; ASTM B-32

C. Wrought-Copper Unions: ASME B16.22.

2.2 JOINING MATERIALS

A. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

SAFE STRENGTH OF SOLDERED JOINTS
Pressure Ratings
Maximum Service Pressure, PSI Water

Solder used in Joints	Service Temperatures Deg. F.	¼ to 1 inch Incl.	1 – ¼ to 2 inches Incl.	2 – ½ to 4 inches Incl.	6 inches
95-5 Tin-Antimony	100	500	400	300	260
	150	400	350	275	260
	200	300	250	200	250
	250	200	175	150	250
Brazing Filler Metal* at or above 1000°F	250	300	210	170	150
	350	270	190	155	150

*For service temperatures 200°F and below, the rated internal pressure is equal to that of tube being joined.

B. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

2.3 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Charlotte Pipe and Foundry Company.

b. IPEX Inc.

c. KBi.

2. PVC one-piece fitting with one threaded brass or copper insert and one Schedule 80 solvent-cement-joint end.

B. Plastic-to-Metal Transition Unions:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Charlotte Pipe and Foundry Company.

b. IPEX Inc.

c. KBi.

d. NIBCO INC.

2. MSS SP-107, PVC union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and threaded union.

2.4 DIELECTRIC FITTINGS

A. General Requirements: Assembly or fitting with separating nonconductive insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion.

1. Combination of copper alloy and ferrous materials with separating nonconductive insulating material

2. Threaded, solder, plain, and weld neck end connection types compatible with piping system materials.

3. Insulating material shall be suitable for system fluid, temperature and pressure and shall not restrict flow.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Capitol Manufacturing Company.

b. Central Plastics Company.

c. Hart Industries International, Inc.

d. Jomar International Ltd.

e. Matco-Norca, Inc.

f. McDonald, A. Y. Mfg. Co.

g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

h. Wilkins; a Zurn company.

2. Description:

a. Standard: ASSE 1079.

b. Pressure Rating: Minimum pressure rating equal to pressure rating of piping system installed.

c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Capitol Manufacturing Company.

b. Central Plastics Company.

c. Matco-Norca, Inc.

d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

e. Wilkins; a Zurn company.

2. Description:

a. Standard: ASSE 1079.

b. Factory-fabricated, bolted, companion-flange assembly.

c. Pressure Rating: Minimum pressure rating equal to pressure rating of piping system installed.

d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Description:

a. Nonconducting materials for field assembly of companion flanges.

b. Pressure Rating:

c. Gasket: Neoprene or phenolic.

d. Bolt Sleeves: Phenolic or polyethylene.

e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Elster Perfection.

b. Grinnell Mechanical Products.

c. Matco-Norca, Inc.

d. Precision Plumbing Products, Inc.

e. Victaulic Company.

2. Description:

a. Standard: IAPMO PS 66

b. Electroplated steel nipple. complying with ASTM F 1545.

c. Pressure Rating: Minimum pressure rating equal to pressure rating of piping system installed.

d. End Connections: Male threaded, grooved or plain.

e. Lining: Inert and noncorrosive, thermoplastic.

2.5 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23, Section titled "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23, Section titled "Instrumentation and Control for HVAC."

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

PIPE AND PIPE FITTING SCHEDULE (HYDRONIC)			
SERVICE	PIPE SIZE (INCHES)	PIPE MATERIAL	FITTINGS
Drain Piping	4 inches and smaller	ASTM-B88; Hard Drawn Type "L" Copper	Wrought copper; Brazed (B CUP-5); ASME-B16.22; Dielectric Fitting between valves and copper pipe where required
Refrigerant Piping		See Division 23; Section titled "Refrigerant Piping"	See Division 23; Section titled "Refrigerant Piping"

3.2 HYDRONIC PIPING SPECIALTIES INSTALLATION

A. Comply with the requirements in Division 23; Section “Hydronic Piping Specialties” for installation requirements hydronic system appurtenances.

3.3 VALVE APPLICATIONS

A. Furnish and Install valves shown on drawings and/or as necessary for control and easy maintenance of all piping and equipment.

B. See Division 23; Section titled “General-Duty Valves for HVAC Piping for valve requirements.

C. Valves shall have a minimum working pressure and material as specified for the piping system installed in.

D. Ball and butterfly valves shall be installed wherever possible.

E. Furnish and install check valves at each pump discharge and elsewhere as required to control flow direction.

3.4 DIELECTRIC FITTING APPLICATION

A. For all systems, provide dielectric fitting to isolate joined dissimilar materials to prevent galvanic action and stop corrosion.

B. Dielectric fittings shall be of the non-reducing type which shall be suitable for system fluid, pressure and temperature and shall not restrict flow.

C. For factory fabricated equipment, manufacturer shall submit method of compliance or exception (if applicable) in writing as part of the shop drawing.

D. It is the intent of this paragraph that all system components (equipment connections, piping, etc.) whether they are field installed or factory fabricated to comply with subparagraph A above.

3.5 PIPING SYSTEMS--COMMON REQUIREMENTS

A. Install piping as described herein, except where system Sections specify otherwise. Individual piping system specification Sections in Division 23 specify piping installation requirements unique to the piping system.

B. All piping materials shall be compatible for temperature, pressure and service.

C. All piping materials of a given type shall be manufactured by a single source and supplied by a single supplier.

D. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, except where deviations to layout are reviewed on coordination drawings.

E. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.

F. Install piping above accessible ceiling to allow sufficient space for ceiling panel removal

G. Install piping to permit valve servicing.

H. All building service piping (including pressurized piping, condensate vacuum), shall comply with ANSI Standard B31.9 - Building Service Piping, unless noted otherwise.

I. Piping specifications shall be submitted with shop drawings.

J. Install gages, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

K. Furnish and install all necessary float devices, aquastats, thermostats, pressure sensors, etc. required for alarm indication as indicated on the HVAC drawing and other applicable sections of Division 23. Drawing and other applicable sections of Division 23.

L. Minimum pipe size shall be 3/4".

M. Install piping at required slope.

N. Install components having pressure rating equal to or greater than system operating pressure.

O. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.

P. Install piping free of sags and bends.

Q. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, except where indicated.

R. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.

S. Install piping to allow application of insulation plus 1 inch (25 mm) clearance around insulation.

T. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

U. Install fittings for changes in direction and branch connections.

V. Install couplings according to manufacturer's printed instructions

W. Verify final equipment locations for roughing in.

X. Refer to equipment specifications in other Sections of Division 23 for roughing-in requirements

Y. Piping connections: Except as otherwise indicated, making piping connections as specified below:

1. Install unions in piping 2 ½ inches (65 mm) and smaller adjacent to each valve and a final connections to each piece of hydronic equipment having 3 inch (75 mm) or smaller threaded piping connection.

2. Wet Piping System (water): install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

Z. Branch connections to mains or sub-branch connections to branches (screwed or welded) shall be made with Tee Fitting (full line size) when the branch or sub-branch connection is equal to or one pipe size smaller. Reduce fittings shall be used after the Tee fittings. For branch or sub-branch connections to mains or branches that are two pipe sizes or smaller maybe made utilizing a weld-o-let or thread-o-let (ANSI B16.9). Weld-o-lets or thread-o-let shall have the same schedule and pressure standard as the pipe to which they connect. No branch or sub-branch shall be made by burning a hole in the pipe it connects to and welding connection. No connection shall be made using a saddle type fittings. T-drill connections are not permitted in copper piping system.

AA. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

BB. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

CC. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

DD. Install valves according to Division 23; Section titled "General-Duty Valves for HVAC Piping."

EE. Install unions in piping, 2½ inches (DN 65) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

FF. Identify piping as specified in Division 23; Section titled "Identification for HVAC Piping and Equipment."

GG. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23; Section titled "Sleeves and Sleeve Seals for HVAC Piping."

HH. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

II. Installation of Appurtenances and Sensors in Piping:

1. Provide all fittings, wells and openings required for installation of devices to indicate flow, temperature, pressure, etc., in piping systems.

JJ. Pipe systems shall conform to the following requirements

1. All piping connections to coils and equipment shall be made with offsets and bolted flanges (screwed or welded) arranged so that the coil and/or equipment can be serviced or removed without dismantling piping.

KK. Miscellaneous Drains, Vents and Reliefs shall be provided as follows:

1. Pipe miscellaneous drains, from equipment to the nearest open drain, floor drain or roof drain. Provide drain valves whenever required for complete drainage of piping system, including system side of pumps.

2. Provide cap or plug in all open ended piping systems, all open ended valves for future connections, drains and vents.

LL. All pipe shall be reamed out after cutting to remove all burrs.

3.6 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23; Section titled "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

1. See “PIPE HANGER & SUPPORT SCHEDULE” on drawings.

3.7 PIPE JOINT CONSTRUCTION

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

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

3.8 HYDRONIC ACCESSORIES INSTALLATION

A. Install manual air vents at high points in piping, and elsewhere as required for system air venting.

3.9 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for condensate piping connections shall be run full size of pipe indicated and reduce at terminal equipment.

3.10 PRESSURE TESTING - ALL PIPING SYSTEMS

A. Water shall not be introduced into piping systems for testing without water treatment. All piping systems shall be tested to a hydrostatic pressure at least 1-1/2 times the maximum operating pressure (but not less than 125 psig) for a sufficiently long time, but not less than 4 hours, to detect all leaks and defects. Where necessary, piping shall be tested in sections to permit the progress of the job.

B. Hydrostatic Testing Corrosion Inhibitor

1. If sections of system must be hydrostatically tested prior to cleanout, appropriate inhibitor shall be added to the test water at sufficient level to totally passivate metal and provide protective film on pipe surfaces to prevent corrosion prior to cleanout and treatment.

2. Mechanical Contractor shall be responsible to coordinate this treatment with the water treatment contractor. At no time shall the Mechanical Contractor add water to a system without treatment.

3.11 PROTECTION AND CLEANING

A. It shall be this trade's responsibility to store its materials in a manner that will maintain an orderly clean appearance. If stored on-site in open or unprotected areas, all equipment and material shall be kept off the ground by means of pallets or racks, and covered with tarpaulins.

B. The inlet and discharge openings of all equipment shall be kept covered until all local plastering, parging, etc. is completed, and the units are ready to run.

C. Equipment and material if left in the open and damaged shall be replaced, repainted, or otherwise refurbished at the discretion of the owner. Equipment and material is subject to rejection and replacement if in the opinion of the engineer, or in the opinion of the manufacturer's engineering department, the equipment has deteriorated or been damaged to the extent that its immediate use is questionable, or that its normal life expectancy has been curtailed.

D. During the erection protect all insulation, piping, and equipment from damage and dirt. Cap the open top and bottom of all ductwork and piping installed.

E. After completion of project, clean the exterior surface of all equipment included in this division of work including, but not limited to, concrete residue.

3.12 FLUSHING AND CLEANING OF PIPING

A. All piping systems shall be thoroughly flushed out with the approved cleaning chemicals to remove pipe dope, slushing compounds, cutting oils, and other loose extraneous materials. This also includes any piping systems which are not listed as requiring water treatment.

B. Develop plan for flushing and cleaning piping. Submit plan for approval prior to completion of piping. Provide all temporary and permanent piping, equipment, materials necessary to complete flushing and cleaning.

C. Prior to flushing, temporarily remove, isolate or bypass dirt sensitive equipment and devices.

D. Flush all piping with cold water for a minimum of 6 feet per second for one hour, until water runs clear. Water supply shall be equivalent to piping to be flushed. Drain all low points.

E. Circulate flush water prior to installing cleaning chemicals. Provide cleaning chemicals, under the direction of the chemical supplier. Following flushing, install cleaning chemicals and circulate through the entire system for a minimum of one hour, or as directed by chemical supplier. Take water sample for owner's use. Drain system, including all low points. Flush, drain and fill system, circulate for one hour, sample for owner's use. Drain, flush, fill, circulate and sample until system is free of cleaning chemicals, as indicated by analysis of samples.

F. Provide temporary pumps and piping to chemically clean piping at a minimum velocity of 6 fps without using the system pumps.

G. The cleaning chemicals shall be added by the mechanical trade. The chemical supplier shall verify that the chemicals are compatible with all the materials in the systems. The chemical supplier shall instruct as to the proper feed rates, shall check that the cleaning solution is actually in each system, shall instruct the contractor as to when to flush the system and shall check each system following flushing to ensure all cleaning chemicals have been removed from each system.

H. A certificate of cleaning shall be provided by the cleaning chemical supplier to the Architect's representative.

3.13 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints uninsulated and exposed for examination during test.

2. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

3. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

4. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

3. Determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for sufficient time to detect leaks but not less than four (4) hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

6. Where necessary, piping maybe tested in sections to permit the progress of the project.

7. If sections of or the entire piping system must be hydrostatically tested prior to cleaning or piping system, an appropriate corrosion inhibitor shall be added to the test water at sufficient levels to totally passive metal and provide protective film on pipe surfaces to prevent corrosion prior to cleanout and chemical water treatment.

8. HVAC Contractor shall be responsible to coordinate the corrosion inhibitor treatment with the Water Treatment Contractor. At no time shall the HVAC Contractor add water to a system without treatment

9. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.

2. Verify lubrication of motors and bearings.

END OF SECTION 23 21 13

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SECTION 23 21 16 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes special-duty valves and specialties for the following:

1. Condensate-drain piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

2. Air-control devices.

3. Hydronic specialties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated.

1. See Division 23; Section titled “Hydronic Piping” for minimum working pressures and temperature.

2.2 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23; Section titled "General-Duty Valves for HVAC Piping.”

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23; Section titled "Instrumentation and Control for HVAC.”

2.3 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Amtrol, Inc.

b. Armstrong Pumps, Inc.

c. Bell & Gossett Domestic Pump.

d. Nexus Valve, Inc.

e. Taco, Inc.

2. Body: Bronze.

3. Internal Parts: Nonferrous.

4. Operator: Screwdriver or thumbscrew.

5. Inlet Connection: NPS 1/2 (DN 15).

6. Discharge Connection: NPS 1/8 (DN 6).

7. CWP Rating: Minimum working pressure rating equal to working pressure rating of piping system.

8. Maximum Operating Temperature: 225 deg F (107 deg C).

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Furnish and install valves shown on drawings and/or as necessary for control and easy maintenance of all piping and equipment.

B. See Division 23; Section titled “General-Duty Valves for HVAC Piping” for valve requirements.

C. Valves shall have a minimum working pressure and material as specified for the piping system installed.

D. Ball and butterfly valves shall be installed wherever possible.

E. Furnish and install check valves at each pump discharge and elsewhere as required to control flow direction.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping and elsewhere as required for system air venting.

END OF SECTION 23 21 16

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SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Automatic condensate pump units.

1.3 QUALITY ASSURANCE:

A. All equipment or components of this specification section shall meet or exceed the requirements and quality of the items herein specified, or as denoted on the drawings.

B. Ensure pump operation at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer. The pump NPSH shall confirm to the ANSI/HI 9.6.1-1997 standards for Centrifugal and Vertical Pumps for NPSH Margin.

C. Ensure pump pressure ratings are at least equal to system's maximum operating pressure at point where installed, but not less than specified.

D. Equipment manufacturer shall be a company specializing in manufacture, assembly, and field performance of provided equipment with a minimum of 20 years experience.

E. Regulatory Requirements: Comply with provisions of the following:

1. ASME B31.9 "Building Services Piping" for piping materials and installation.
2. Hydraulic Institute's "Standards for Centrifugal, Rotary & Reciprocating Pumps" for pump design, manufacture, testing, and installation.
3. UL 778 "Standard for Motor Operated Water Pumps" for construction requirements. Include UL listing and labeling.
4. NEMA MG 1 "Standard for Motors and Generators" for electric motors. Include NEMA listing and labeling.
5. NFPA 70 "National Electrical Code" for electrical components and installation.

F. Single-Source Responsibility: Obtain each category of pumps from a single- source and by a single manufacturer. Include responsibility and accountability to answer questions and resolve problems regarding compatibility, installation, performance, and acceptance of pumps.

G. Product Options: Drawings indicate sizes, profiles, connections, and dimensional requirements of pumps and are based on the specific types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered. Refer to Division 01 Section "Product Substitutions."

1.4 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

C. HI: Hydronic Institute.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store pumps in dry location.

B. Retain shipping flange protective covers and protective coatings during storage.

C. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

D. Extended Storage Longer than 5 Days: Dry internal parts with hot air or vacuum-producing device. Coat internal parts with light oil, kerosene, or antifreeze after drying.

E. Comply with pump manufacturer's rigging instructions.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 PUMPS - GENERAL

A. Pump Pressure Ratings: At least equal to system's maximum operating pressure at point where installed, but not less than specified. Factory test at 1.5 times working pressure.

B. Water Temperature: Pump to comply with specific application.

C. Mounting: As described under "Vibration Isolation".

D. Pumps shall be selected to operate at or near their point of peak efficiency thus allowing for operation at capacities of approximately 25% beyond design capacity. In addition, the design impeller diameter shall be selected so that the design capacity of each pump (GPM and TDH) shall not exceed 90% of the capacity obtainable with maximum impeller diameter at the design speed for that model.

E. Rising Curve: Pump characteristic curve shall rise continuously from maximum capacity to shut-off, with shut-off head minimum 10 percent greater than the design head.

F. Working Pressure: Construct pumps for the working pressure in pounds per square inch specified or indicated. Factory test at 1.5 times working pressure.

G. General: Factory assembled and tested.

H. Types, Sizes, Capacities, and Characteristics: As indicated.

I. Motors: Furnish single -speed motors, with type of enclosures and electrical characteristics indicated and as specified under another section of this work. Include built-in thermal-overload protection and grease-lubricated ball bearings. Select each motor to be nonoverloading over full range of pump performance curve.

J. Factory Finish: Manufacturer's standard paint applied to factory-assembled and -tested units before shipping.

K. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs

L. Factory Tests: The pumps shall be factory tested, thoroughly cleaned and painted with (1) coat of machinery enamel prior to shipment. The manufacturer shall include a set of installation instructions with the pumps at the time shipment.

2.2 AUTOMATIC CONDENSATE PUMP UNITS

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

1. Beckett Corporation.
2. Hartell Pumps Div.; Milton Roy Co.
3. Little Giant Pump Co.
4. Mepco, LLC.

B. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch- (1800-mm-) minimum, electrical power cord with plug.

C. Capacities and Characteristics:

1. See drawings for Pump capacities and characteristics.

PART 3 - EXECUTION

3.1 COORDINATION

A. Verify that location allows adequate access for proper maintenance, including removing motors, impellers, couplings and accessories.

3.2 EXAMINATION

A. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PUMP INSTALLATION

A. Install pumps according to manufacturer's written installation and alignment instructions.

B. Comply with requirements of Hydronic Institute’s HI 1.4 or HI 2.4 Standards for Centrifugal, Rotary & Reciprocating Pumps, "Instructions for Installation, Operation and Maintenance.

C. Independently support pumps and suction and discharge piping so the weight of the piping is not supported by the pumps and the weight of the pumps in not supported by the piping.
1.

3.4 ALIGNMENT

A. HVAC Contractor shall perform alignment service for all pumps.

B. Comply with pump and coupling manufacturers' written instructions.

3.5 CONNECTIONS

A. Comply with the requirements for piping specified in the following sections of Division 23; titled

1. Meters and Gages
2. General Duty Valves
3. Hangers and Supports
4. Hydronic Piping
5. Other applicable Sections of Division 23

B. Install piping to allow for proper pump service and maintenance

C. Suction and discharge piping shall be brought to equipment and pump connections in such a manner so as to prevent the possibility of any loads or stresses being applied to the connections or piping. All piping shall be fitted to the pumps even though piping adjustments may be required after the pipe is installed.

D. Pipe diameter of piping for pumps suction and discharge shall be equal to or greater than diameter of pump suction and discharge connections.

E. Install check valve, shut off valve or combination balancing/shut-off valve on pump discharge piping.

F. Install shut-off valves on pump suction. Where there is less than 5 straight pipe diameters of pipe at the pump suction, provide a pump suction diffuser at pump suction.

G. Where reduction from line size to pump connection, connection shall be made with eccentric reducers attached to the pump with tops flat to allow continuity of flow.

H. Pumps with mechanical seals install flushing line and where required return/drain line.

I. Install gate valve and check valve on the discharge pipe from each automatic condensate units.

J. Electric power connections shall be provided as part of the work of Division 26. HVAC contractor shall review with Contractor for Division 26 to ensure connection are in accordance with pump manufacturer's recommendation.

K. Provide pipe wells and other appurtenances required for the work of Division 23 Sections titled "Instrumentation and Control of HVAC Equipment" and "Sequence of Operation for HVAC Controls".

3.6 FIELD QUALITY CONTROL

A. Check suction piping connections for tightness to avoid drawing air into pumps.

B. Check Alignment.

C. Verify that piping is not supported by pump.

D. Set pump controls.

E. Guarantee: Pump to deliver required GPM against design and within ±3% without over-heating motor, bearings or any other parts and without producing noise audible outside the space in which the pumps are installed. Certified test statements to be provided for each pumping unit. Seals to be replaced without charge if faulty operation or unusual wear occurs during guarantee period, not caused by maintenance faults.

3.7 START-UP

A. Start -up: Pumps shall be installed in accordance with the standards of the Hydraulic Institute.

B. Final Checks Before Startup: Perform the following preventive maintenance operations and checks before startup:

1. Lubricate bearings.
2. Remove grease-lubricated bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's recommendations.
3. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
4. Check that pumps are free to rotate by hand.
5. Check that pump controls are correct for required application.
6. HVAC Contractor shall have a manufacturer’s representative/engineer check the motors and pumps for proper alignment glands for proper tightness, seal flushing system, all bearings for proper lubrication, etc. before pumps are started. If manufacturer’s representative/engineer finds any of the pumps components that are not in accordance manufacturer’s requirements or specifications, defects shall be corrected and re-examined by manufacturer’s representative/engineer.
7. Manufacturer’s representative/engineer shall submit a certified letter stating that the pumps are installed with manufacturer’s recommendations.
8. The HVAC Contractor shall instruct the Testing and Balancing Subcontractor to take amperage readings on each phase of all pump motors and after 15 days Of operation the HVAC Contractor shall recheck and adjust as required alignment and gland tightness and bearing lubrication.

C. Starting procedure for pumps starting against shut-off head (pump discharge valve closed) and with non-overloading motor.

1. Prime pumps, opening suction valve, closing drains, and preparing pumps for operation.
2. Open water supply valves water supply to bearings, where applicable.
3. Open sealing liquid supply valves if pumps are so fitted.
4. Open warm-up valves of pumps handling hot liquids if pumps are not normally kept at operating temperature.
5. Open circulating line valves if pumps should not be operated against dead shutoff.
6. Start motors.
7. Open discharge valves slowly.
8. Check general mechanical operation of pumps and motors.
9. Close circulating line valves once there is sufficient flow through pumps to prevent overheating.

D. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed requirements for testing, adjusting, and balancing hydronic systems.

E. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except that discharge valves are opened sometime before motors are started.

F. Refer to Division 23 Section titled "Testing, Adjusting, and Balancing for HVAC" for detailed requirements for testing, adjusting, and balancing hydronic systems.

1. Testing, adjusting and balancing shall be provided as part of the work of the above referenced Section. HVAC Contractor shall assist Testing Adjusting and Balancing Subcontractor as required with labor and material.

END OF SECTION 23 21 23

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SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract including but not limited to

1. General and Supplementary Conditions

2. Division 01 Specification Sections

3. Division 23; Section titled “Vibration Controls for Mechanical Electrical Systems (Non-Seismic)”

4. Division 23; Section titled “Hangers and Supports for HVAC Piping and Equipment”

5. Other Applicable Sections of Division 23

6. Division 07; Section titled “Roof Accessories”

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications. Include but not be limited to

1. Pipe, tubing, fittings and specialties

2. Special duty valves

3. Refrigerants

1.3 PERFORMANCE REQUIREMENTS

A. The following subparagraphs are minimum test requirements. HVAC Contractor to coordinated with equipment manufacturer to determine the working pressure of the various types of piping system.

1. If working pressure times 1.5 is less than test pressures listed in the following subparagraph, piping system shall be tested at listed pressures in the following subparagraph.

2. If working pressure times 1.5 is greater than test pressures listed in following subparagraphs, test piping systems at higher pressures.

B. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).

2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).

3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.

2. Solenoid valves.

3. Hot-gas bypass valves.

4. Filter dryers.

5. Strainers.

6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Shop Drawing Scale: Same scales as shop drawing for ductwork and piping shop drawings are being prepared at.

2. Refrigerant piping indicated on Drawings is schematic only. HVAC Contractor in conjunction with equipment manufacturer shall size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

D. Comply with requirements of ASTM 828 “Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.

E. ANSI/AWS A5.8 “Specification for Filler Metals for Brazing.”

F. ANSI/AWS A5.31 “Specification for Fluxes for Brazing and Braze Welding.”

G. ANSI/AWS B2.2 “Standard for Brazing Procedure and Performance Qualification.”

H. ASME B16.22 “Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.”

1.8 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.9 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type L. Tubing shall be factory cleaned, ready for installation, and have ends capped to protect cleanliness of pipe interiors prior to shipping.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:

1. Body: Seamless tin/bronze core with high tensile bronze braid jacket.

2. End Connections: Socket ends.

3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.

4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).

5. Maximum Operating Temperature: 250 deg F (121 deg C).

2.2 REFRIGERANT VALVES

A. General;

1. Refrigerant valves and specialties assemblies shall be UL listed and conform to AHRI 760 where applicable.

B. Globe Valve

1. Body; Cast bronze body with cast bronze or forged brass wing cap and bolted bronze bonnet

2. Replaceable resilient disc (compatible with refrigerant valve installed)

3. Plated steel stem

4. Working Pressure Rating; Minimum 400 Psig

5. Operating Temperature; 275°F

6. Valve capable of being repacked under pressure

7. End Connection; Socket (solder)

C. Ball Valve

1. Body; Foraged Brass with brass seal cap and full port construction to match line size interior diameter

2. Ball; Chromium-plated, internally equalized ball design

3. Seal; Compatible with CFC, HCFC and HFC refrigerant and oils

4. Stem; Rupture-proof encapsulated design

5. Manual valve positioning

6. Maximum Working Pressure; 700 Psig

7. Operating Temperature Range; -40°F to 300°F

8. UL/cUL listed; CE certified

9. End Connection; Socket (solder)

10. Where required, provide motorized actuator; gradual open/close to eliminate water hammer; manual override and valve positioning; electronic overload protection; electric power as required by system design.

D. Check Valves (5/8 inch and smaller)

1. Body; Cast brass with straight through "Y" type design
2. Bonnet; Screwed type for access to internal components.
3. Compatible with CFC, HCFC and HFC refrigerant and oils
4. Pressure Drop; Internal components design to limit pressure drop to < 1 Psi
5. Valve design to allow for easy removable of components for replacement
6. Spring; Stainless steel
7. Seat; Teflon
8. Maximum Working Pressure; 700 Psig
9. Operating Temperature Range; -40°F to 300°F
10. Maximum Opening Pressure; 0.50Psig
11. UL/cUL listed; CE certified
12. End Connection; Socket (solder)

E. Check Valve (7/8 inch and larger)

1. Body; Cast brass with straight through "Y" type design
2. Bonnet; Bolted type (four-bolt design) for access to internal components.
3. Compatible with CFC, HCFC and HFC refrigerant and oils
4. Pressure Drop; Internal components design to limit pressure drop to < 1 Psi
5. Valve design to allow for easy removable of components for replacement
6. Spring; Stainless steel
7. Seat; Teflon
8. Gasket Material; Non-asbestos compatible with refrigerants and oils
9. Maximum Working Pressure; 700 Psig
10. Operating Temperature Range; -40°F to 300°F

11. Maximum Opening Pressure; 0.50Psig

12. UL/cUL listed; CE certified

13. End Connection; Socket (solder)

F. Strainer

1. Body; Forged brass; "Y" pattern design

2. Screen; Stainless steel; 100 mesh

3. Screwed cleanout plug

4. Maximum Working Pressure; 700 Psig

5. Operating Temperature Range; -40°F to 300°F

6. UL/cUL listed; CE certified

7. End Connection; Socket (solder)

G. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.

2. Diaphragm: One phosphor bronze and two stainless steel with stainless-steel spring.

3. Operator: Rising stem and hand wheel.

4. Seat: Nylon.

5. End Connections: Socket, union, or flanged.

6. Working Pressure Rating: 500 psig (3450 kPa).

7. Maximum Operating Temperature: 275 deg F (135 deg C).

8. Hermetic seal between bonnet, diaphragm and body

9. Positive backseating with valve in wide open position

10. Non-directional flow

11. Diaphragm replaceable under line pressure

H. Packed-Angle Valves:

1. Body and Bonnet: Forged brass or cast bronze.

2. Packing: Molded stem, back seating, and replaceable under pressure.

3. Operator: Rising stem.

4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.

5. Seal Cap: Forged-brass.

6. End Connections: Socket, union, threaded, or flanged.

7. Working Pressure Rating: 500 psig (3450 kPa).

8. Maximum Operating Temperature: 275 deg F (135 deg C).

I. Service Valves:

1. Body: Forged brass with brass cap including key end to remove core.

2. Core: Removable ball-type check valve with stainless-steel spring.

3. Seat: Polytetrafluoroethylene.

4. End Connections: Copper spring.

5. Working Pressure Rating: 500 psig (3450 kPa).

2.3 REFRIGERANT SPECIALTIES

A. Refrigerant valves and specialties assemblies shall be UL listed and conform to AHRI 760 where applicable

B. Moisture/liquid Indicators

1. Body; Forged brass

2. Window; Replaceable, clear, fused glass with indicating element protected by filter screen

3. Indicator; Color coded to show moisture content in parts per million (ppm)

4. Maximum Working Pressure; 500 Psig

5. Maximum Operating Temperature ; 240°F

6. UL/cUL listed; CE certified

7. End Connection; Socket (solder)

8. Compatible with CFC, HCFC and HFC refrigerant and oils

C. Filter Dryer

1. Comply with requirements of AHRI 730
2. Replaceable core design
3. Body & Cover; Painted steel shell with ductile iron cover stainless steel screws and neoprene gaskets
4. Filer Media; design to filter down to 25 micron
5. Desiccant Media; Activated Alumina; Ratio of desiccant media and molecular sieve as recommended by refrigerant manufacturer for both liquid line and suction filter dryers.
6. End Connections; Socket or flare per piping system design
7. Access Ports; For suction line filter dryer only, schraeder access valves at inlet and outlet.
8. Maximum Pressure Drop; Less than 2 Psig
9. Working Pressure; 500 Psig for all refrigerants except R 410A. R 410A 660 Psig
10. Maximum Operating Temperature; 240°F

D. Permanent Filter Dryer

1. Comply with requirements of AHRI 730
2. Permanent core design
3. Body; Painted steel shell
4. Filer Media; design to filter down to 25 micron
5. Desiccant Media; Activated Alumina; Ratio of desiccant media and molecular sieve as recommended by refrigerant manufacturer for both liquid line and suction filter dryers.
6. End Connections; Socket or flare per piping system design
7. Access Ports; For suction line filter dryer only, schraeder access valves at inlet and outlet.
8. Maximum Pressure Drop; Less than 2 Psig
9. Working Pressure; 500 Psig for all refrigerants except R 410A. R 410A 660 Psig
10. Maximum Operating Temperature; 240°F

E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by an NRTL.

1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

3. Seat: Polytetrafluoroethylene.

4. End Connections: Threaded.

5. Electrical: Molded, watertight coil in NEMA 4 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter. Coil voltage as required by system requirements.

6. Working Pressure Rating: 400 psig (2760 kPa).

7. Maximum Operating Temperature: 240 deg F (116 deg C).

8. Manual operator.

F. Safety Relief Valves: Comply with ASHRAE Standard 15 and ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.

2. Piston, Closing Spring, and Seat Insert: Stainless steel.

3. Seat Disc: Polytetrafluoroethylene.

4. End Connections: Threaded.

5. Working Pressure Rating: 400 psig (2760 kPa).

6. Maximum Operating Temperature: 240 deg F (116 deg C).

G. Thermostatic Expansion Valves: Comply with AHRI 750.

1. Body, Bonnet, and Seal Cap: Forged brass.

2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.

3. Packing and Gaskets: Non-asbestos.

4. Capillary and Bulb: Copper tubing filled with refrigerant charge.

5. Suction Temperature: As required per system design.

6. Superheat: Adjustable.

7. Reverse-flow option (for heat-pump applications).

8. End Connections: Socket, flare, or threaded union.

9. Working Pressure Rating; As required for refrigerant type but not less than 450 psig.

10. External equalizer line

11. Valve design specific for refrigerant type

12. Distributer with side connection for hot gas by-pass connection

13. Balance port design.

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

1. Body, Bonnet, and Seal Cap: Ductile iron or steel.

2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.

3. Packing and Gaskets: Non-asbestos.

4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.

5. Seat: Polytetrafluoroethylene.

6. Equalizer: External.

7. Electrical: Molded, watertight coil in NEMA 4 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter. Coil voltage as required by system requirements. .

8. End Connections: Socket.

9. Set Pressure: As required by system design.

10. Throttling Range: Maximum 5 psig (34 kPa).

11. Working Pressure Rating: 500 psig (3450 kPa).

12. Maximum Operating Temperature: 240 deg F (116 deg C).

I. Evaporator Pressure Regulator Valves

1. Body; Forged Brass

2. Pilot-operate

3. Solenoid stop to close valve during system defrost cycle

4. Normally open design to allow for system evacuation without manual operator. If normally closed design required for system operation, provide manual operator

5. Worker Pressure Rating; 450 psig

6. Maximum Fluid Temperature; 240°F

7. Agency Listing; UL/ULc listed.

8. End Connection; Socket.

J. Mufflers:

1. Body: Welded steel with corrosion-resistant coating.

2. End Connections: Socket or flare.

3. Working Pressure Rating: 500 psig (3450 kPa).

4. Maximum Operating Temperature: 275 deg F (135 deg C).

K. Receivers: Comply with AHRI 495.

1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

2. Comply with UL 207; listed and labeled by an NRTL.

3. Body: Welded steel with corrosion-resistant coating.

4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.

5. End Connections: Socket or threaded.

6. Working Pressure Rating: 500 psig (3450 kPa).

7. Maximum Operating Temperature: 275 deg F (135 deg C).

L. Liquid Accumulators: Comply with AHRI 495.

1. Body: Welded steel with corrosion-resistant coating.

2. End Connections: Socket or threaded.

3. Working Pressure Rating: 500 psig (3450 kPa).

4. Maximum Operating Temperature: 275 deg F (135 deg C).

2.4 REFRIGERANTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Atofina Chemicals, Inc.

2. DuPont Company; Fluorochemicals Div.

3. Honeywell, Inc.; Genetron Refrigerants.

4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 4 (DN 100) and Smaller for Conventional Air-Conditioning Applications: Copper, Type L (B), drawn-temper tubing and wrought-copper fittings.

B. Hot-Gas and Liquid Lines: Copper, Type L (B), annealed- or drawn-temper tubing and wrought-copper fittings.

C. Safety-Relief-Valve Discharge Piping: Copper, Type L (B), annealed- or drawn-temper tubing and wrought-copper fittings.

3.2 EXAMINATION

A. Examine rough in for refrigerant piping systems to verify actual locations of piping connections prior to installation.

3.3 PIPING INSTALLATIONS

A. Drawing are diagrammatic and indicate general location and arrangement of piping system. Install piping as indicated unless deviations are approved on Shop Drawing.

B. General: Install refrigerant piping in accordance with ASHRAE Standard 15 "The Safety Code for Mechanical Refrigeration."

C. Install piping in as short and direct arrangement as possible to minimize pressure drop.

D. Install piping for minimum number of joints using as few elbows and other fittings as possible.

E. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Install valves and specialties in accessible locations to allow for servicing and inspection.

F. Provide adequate clearance between pipe and adjacent walls and hanger, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full thickness insulation.

G. Install piping in areas where piping is exposed, mechanical room and service areas at right angles or parallel to building walls. Diagonal pipe runs are prohibited unless specifically indicated otherwise.

H. Install piping above accessible ceilings to allow for sufficient space for ceiling panel removal.

I. Install piping adjacent to equipment to allow for service and maintenance.

J. Insulate suction lines. Liquid line are not required to be insulated, except where they are installed adjacent and clamped to suction lines, where both liquid and suction lines shall be insulated as a unit.

K. Do not install insulation until system testing has been completed and all leaks have been eliminated.

L. Install branch tie in lines to parallel compressors equal length, and pipe identically and symmetrically.

M. Install copper tubing in rigid conduit in locations where copper tubing will be exposed to mechanical injury.

N. Slope refrigerant piping as follows:

1. Install horizontal hot gas discharge piping with 1/2" per 10 feet downward slope away from the compressor.

2. Install horizontal suction lines with 1/2 inch per 10 feet downward slope to the compressor, with no long traps or dead ends which may cause oil to separate from the suction gas and return to the compressor in damaging slugs.

3. Install traps and double risers where indicated, and where required to entrain oil in vertical runs.

4. Liquid lines may be installed level.

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

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

Q. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

R. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

S. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

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

U. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6 inch shall be steel; pipe sleeves 6 inch and larger shall be sheet metal.

V. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

W. Install strainers immediately upstream and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Solenoid valve

2. Thermostatic expansion valve

3. Hot gas by-pass valve

4. Compressor

5. At other system components in piping system that require protection.

X. Install moisture/liquid indicators in liquid lines between filter/driers and thermostatic expansion valves and in liquid line to receiver.

1. Install moisture/liquid indicators in lines larger than 2 1/8 inch OD, using a bypass line.

Y. Install unions to allow removal of solenoid valves, pressure regulating valves, expansion valves, and at connections to compressors and evaporators.

Z. Install flexible connectors at the inlet and discharge connection of compressors.

AA. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

BB. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

CC. Identify refrigerant piping and valves according to Division 23; Section titled "Identification for HVAC Piping and Equipment."

DD. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23; Section titled "Sleeves and Sleeve Seals for HVAC Piping."

EE. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23; Section titled "Sleeves and Sleeve Seals for HVAC Piping."

FF. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23; Section titled "Escutcheons for HVAC Piping."

3.4 VALVE AND SPECIALTY APPLICATIONS

A. General: Install refrigerant valves where indicated, and in accordance with manufacturer's instructions.

B. Install globe valves on each side of strainers and driers, in liquid and suction lines at evaporators, and elsewhere as indicated.

C. Install a full sized, 3 valve bypass around each drier.

D. Install solenoid valves ahead of each expansion valve and hot gas bypass valve. Install solenoid valves in horizontal lines with coil at the top.

1. Electrical wiring for solenoid valves is installed by this contractor to meet requirements specified in Division 26. Coordinate electrical requirements and connections.

E. Thermostatic expansion valves may be mounted in any position, as close as possible to the evaporator.

1. Where refrigerant distributors are used, mount the distributor directly on the expansion valve outlet.

2. Install the valve in such a location so that the diaphragm case is warmer than the bulb.

3. Secure the bulb to a clean, straight, horizontal section of the suction line using two bulb straps. Do not mount bulb in a trap or at the bottom of the line.

4. Where external equalizer lines are required make the connection where it will clearly reflect the pressure existing in the suction line at the bulb location.

F. Install Compressor shut-off valves in suction and discharge lines of compressor.

G. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

H. Install a check valve at the compressor discharge and a liquid accumulator (where required by manufacturer) at the compressor suction connection.

I. Except as otherwise indicated, install either diaphragm packless or packed-angle valves on inlet and outlet side of filter dryers.

J. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

L. Where compressor manufacturer additional protection, install a suction filter/dryer in suction line at compressor inlet.

M. Install receivers sized to accommodate pump-down charge.

N. Install flexible connectors at compressors.

3.5 PIPE JOINT CONSTRUCTION

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

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing, to prevent scale formation.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.

2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

E. Mechanical fittings (crimp or flare) are not permitted

3.6 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23; Section titled "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.

2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.

3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.

4. Spring hangers to support vertical runs.

5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Support multifloor vertical runs at least at each floor.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.

2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.

3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

a. Fill system with nitrogen to the required test pressure.

b. System shall maintain test pressure at the manifold gage throughout duration of test.

c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.

d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.8 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.

3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).

4. Charge system with a new filter-dryer core in charging line.

3.9 ADJUSTING AND CLEANING

A. Before installation of copper tubing, clean the tubing and fitting using following cleaning procedure:

B. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through the tubing by means of a wire or an electrician's tape.

C. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.

D. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.

E. Finally, draw a clean, dry, lintless cloth through the tube or pipe.

F. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

G. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

H. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

I. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.

2. Verify that compressor oil level is correct.

3. Open compressor suction and discharge valves.

4. Open refrigerant valves except bypass valves that are used for other purposes.

5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

J. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 23 23 00

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SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.

2. Single-wall round ducts and fittings.

3. Sheet metal materials.

4. Duct liner.

5. Sealants and gaskets.

6. Hangers and supports.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.

2. Section 230713 Duct Insulation.

3. Section 230720 Acoustical Duct Lining and Duct Wrap.

4. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, seal and leakage classification shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravityloads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.

2. Sealants and gaskets.

3. Leakage test procedure and calculations for review and approval for all duct sections/segments subject to leak testing.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."

4. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-up."

5. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content. “

6. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.

2. Factory- and shop-fabricated ducts and fittings.

3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.

4. Elevation of bottom of ducts.

5. Dimensions of main duct runs from building grid lines.

6. Fittings.

7. Reinforcement and spacing.

8. Seam and joint construction.

9. Penetrations through partitions.

10. Equipment installation based on equipment being used on Project.

11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

12. Hangers and supports, including methods for duct and building attachmentand vibration isolation.

D. Design Submittal:

1. Sheet metal thicknesses.

2. Joint and seam construction and sealing.

3. Reinforcement details and spacing.

4. Materials, fabrication, assembly, and spacing of hangers and supports.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout to accommodate other building services. See Spec Section 230000 titled “Basic Mechanical Requirements”.

2. Items penetrating finished ceiling including the following:

a. Lighting fixtures.

b. Air outlets and inlets.

c. Speakers.

d. Sprinklers.

e. Access panels.

f. Perimeter moldings.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. SMACNA HVAC Duct Construction Standards, Metal and Flexible, Third Edition, 2005.

B. SMACNA HVAC Air Duct Leakage Test Manual, Second Edition, 2012.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

1.7 DEFINITIONS

A. Sealing Requirement Definitions: For the purposes of duct systems sealing specified in this Section, the following definitions apply:

1. Seams: A seam is defined as jointing of two longitudinally (in the direction of air flow) oriented edges of duct surface material occurring between two joints. All other duct surface connection made on perimeter are deemed to be joints.

2. Joints: Joints include transverse joints, offsets and transitions, girth joints, louver and air terminal connection to ducts; elbows access panel frames and jamb; duct, plenum, and casing abutments to building structures.

3. Wall penetrations: Include duct fittings, branch and subbranch connections, tees (figure 4-6), divided flow branches, duct collar tap-ins, access doors, etc. (SMACNA Figures 4-5 & 4-6)

1.8 SYSTEM PERFORMANCE REQUIREMENTS

A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alternation to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modification with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" Chapter 2 Rectangular Duct Construction based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Button punch and snap lock is not acceptable. (SMACNA Figure 2-2, Type L-2)

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches (1524 mm) in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90 (Z275).

2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

D. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

F. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

1. Tie Rods: Tie-rod attachments, joint and mid panel tie-rod applications shall be in accordance with SMACNA HVAC Duct Construction Manual sections 2.5 thru 2.9.

2.4 SPECIAL DUCTWORK CONSTRUCTION

A. Ductwork required to be removable shall be companion flanged SMACNA Type T-22.

B. Ductwork systems serving areas of high humidity shall be constructed of stainless steel 316L, or aluminum with gauges in accordance with SMACNA Standards as referenced above (minimum 16 gage). Ductwork shall be continuously welded or soldered watertight. Pitch duct to low point drains. Pipe drains (1" copper drain line) to floor drains or utility sinks.

1. Areas include

a. Exhaust ductwork exposed on roof.

C. Ductwork exposed to weather

1. After exposed ducts and joints are sealed and tested as specified, apply over and around the same areas of possible leakage (joints), an approved sealer system. Ductwork outside the building shall be installed in a manner to result in A SMACNA leakage classification of 4 for rectangular and (2) for round ducts.

2. Exposed supply and return air ductwork shall be insulated and weather-protected as specified under duct insulation specification, Section 230713, Item 2.14 weatherproofing finishes for outdoor ductwork (supply return, exhaust). Insulate after the ductwork installation has been completed and leak tested.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

2. Tape Width: 3 inches (76 mm) 4 inches (102 mm) 6 inches (152 mm).

3. Sealant: Modified styrene acrylic.

4. Water resistant.

5. Mold and mildew resistant.

6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.

7. Service: Indoor and outdoor.

8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.

2. Solids Content: Minimum 65 percent.

3. Shore A Hardness: Minimum 20.

4. Water resistant.

5. Mold and mildew resistant.

6. VOC: Maximum 75 g/L (less water).

7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.

8. Service: Indoor or outdoor.

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

12. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.

13. Service: Indoor or outdoor.

14. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.

2. Type: S.

3. Grade: NS.

4. Class: 25.

5. Use: O.

6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage classification of 2 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) static-pressure class, positive or negative.

2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings. Changes in duct sizes and location to conform to space conditions or coordination with other building services shall be made at no additional cost to the Owner.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible". If local codes require other standards that are more stringent, local codes shall govern.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

L. All required supports, hangers, anchors, and guides shall be provided and installed by this contractor.

M. All ductwork; register boxes, air chambers, dampers, and all auxiliary work of any kind, necessary to make the various air conditioning, ventilating and heating systems of the building complete and ready for operation, shall be furnished and installed.

N. Dimensions given on drawings of all acoustically lined ducts shall be the clear inside dimension. Refer to "Acoustical Treatment".

O. Where the trade elects to use "Duct-Mate" for joints or similar product, PVC clips are not permitted (use metal) and all corners shall be bolted (boltless connectors are not permitted) except where local codes permit Duct-Mate joints as breakaway connection at fire dampers. Only gaskets manufactured by Duct-Mate are acceptable.

P. Use gasketed type joint when dissimilar metals are joined.

Q. All ductwork unless otherwise noted shall be hung with 1 in. x 1/8 in. galvanized iron bands. Ductwork with cross sectional area under 4 square feet shall be hung on 8'-0 in. centers. For ducts with a cross-sectional area of more than 4 sq. ft. but not over 10 sq. ft. hangers shall be no more than 6 feet apart, and for ducts with a cross sectional area of more than 10 sq. ft. hangers shall be no more than 4 ft. apart. All hangers shall be bent (2" minimum) under the bottom as well as the sides and secured with sheet metal screws.

R. Where ducts are stacked they shall be independently supported as above or shall be supported per SMACNA Duct Construction Standards - Metal and Flexible Chapter 5.

S. All ductwork shall be substantially built with approved joints and seams smooth on the inside and a neat finish on the outside. Duct joints as near airtight as possible, with laps made in the direction of air flow and no flanges projecting into the air stream. Ducts shall be adequately braced to prevent vibration. All angles shall be galvanized or shop painted with two coats of rust resistant paint.

T. Changes in shape and dimension shall conform to the following:

1. For increases in cross-sectional area, the shape of the transformation shall not exceed 1" in 7".

2. For reductions in area the slope may be 1" in 4" but 1" in 7" is preferred.

U. Changes in direction shall conform to the following:

1. Unvaned elbow with throat radius not less than ½ the width of the duct.

2. Square elbows with single vane turning vanes shall be as per SMACNA with 3-1/4" spacing and are acceptable in ducts with not more than 2200 FPM air velocity. For higher velocities, use sweep type vanes.

V. Turning vanes shall be single blade turning vanes fabricated from the same material as the duct. Large radius vanes shall be used. The maximum unsupported vane length shall not exceed 36". Tab spacing shall be SMACNA standard. Vanes shall be welded to runners. Rail systems with non-standard tab spacings shall not be accepted. All tabs shall be used, do not skip tabs. Mounting rails shall have friction insert tabs which align the vanes automatically. Vanes shall be subjected to tensile loading and be capable of supporting 250 lbs when fastened per the manufacturer's instructions.

W. Wherever it may be necessary to make provisions for vertical hangers of the ceiling construction passing through ducts, provide streamlined shaped sleeves around such ceiling construction hangers as to fully protect the duct from being punched with holes for the passage of such hangers. Any such streamlined sleeves shall be made airtight at top and bottom of ducts. In no case shall there be more than two rods in any 9 sq. ft. area. No rods shall pierce ducts smaller than 12" in horizontal area.

X. Where automatic dampers are shown on drawings or are required, their selection shall be made so that the frames, stops, etc. of such dampers are outside of the airstream so as to provide a nominal 100% free area damper.

Y. Furnish and install manual dampers, registers, grilles, register boxes, access doors, sound traps, etc., as described elsewhere in the specifications and as required for a complete system, ready for operation.

Z. Exact dimensions of register boxes must await approval of grilles, and exact locations shall be submitted for approval, otherwise any changes directed after installation shall be made without additional cost. All register boxes and other opening of the ductwork must be kept tightly closed during construction to keep out rubbish.

AA. Access doors as specified elsewhere shall be provided in the ducts wherever required for access to dampers or other controls.

BB. Provide No. 16 USSG, 3/4" wire mesh screen over each open return duct in hung ceiling unless register or grille is shown.

CC. Dryer exhaust shall be constructed and assembled without the use of sheet metal screws in longitudal seams. The interior surface of the duct shall be smooth without any projections. If overlap joints are used to assemble the duct sections, the male end of the overlap shall extend in the direction of air flow. Sheetmetal screws shall not protrude more than 1/8” in the air stream and joints shall be covered with UL listed duct tape. Provide a cleanout at the base of each dryer riser.

DD. Only flexible ductwork listed, labeled, and in compliance with UL 2158A shall be used for dryer transition ducts. Dryer transition ducts must be a single length with no connecting sections allowed. Dryer transition ducts shall not be concealed within construction, such as passing through floors, walls, hidden spaces, etc., or be longer than 8 feet.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in Item 3.14 of this specification duct schedule.

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2. Outdoor, Supply-Air Ducts: Seal Class A.

3. Outdoor, Exhaust Ducts: Seal Class C.

4. Outdoor, Return-Air Ducts: Seal Class C.

5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class B.

6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class A.

7. Unconditioned Space, Exhaust Ducts: Seal Class C.

8. Unconditioned Space, Return-Air Ducts: Seal Class B.

9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class C.

10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class B.

11. Conditioned Space, Exhaust Ducts: Seal Class B.

12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.

2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

G. Hanger and supports for ducts requiring lagging and/or dry-wall enclosure shall include the additional weight of the lagging and/or dry-wall enclosure.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Duct Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test. Test ducts in accordance with Item 3.14 Duct Schedule for duct system construction static pressure, seal classification and leakage classification.

2. Duct leakage testing shall be conducted during construction phase where full access to risers are available and leakage testing can be 100% completed prior to construction enclosing then.

3. Test the following systems:

   a. All ducts (supply, return, exhaust etc.) Pressure Class +/- 2" W G. and higher, before insulation is applied shall be pressure tested at scheduled external static pressure and joints for all mains, risers and branches shall be check for leakage and repair if necessary. Noisy and whistling leaks shall be repaired, and the system shall then be retested

      (1) Duct risers shall be constructed to minimum 3" static pressure classification and/or higher pressure classification as called for on duct schedule.

   b. Supply Ducts with a Pressure Class 2-inch wg (500 Pa) and Higher: Test representative duct sections, totaling no less than 100 percent of total installed duct area for each designated pressure class.

   c. Return Ducts with a Pressure Class 2-Inch wg (500 Pa) and Higher: Test representative duct sections, totaling no less than 100 percent of total installed duct area for each designated pressure class.

   d. Exhaust Ducts with a Pressure Class 2-Inch wg (500 Pa) and Higher: Test representative duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.

   e. Outdoor Air Ducts with a Pressure Class 2-Inch wg (500 Pa) and Higher: Test representative duct sections, totaling no less than 100 percent of total installed duct area for each designated pressure class.

4. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

5. Test for leaks before applying external insulation.

6. Conduct tests at static pressures equal to maximum design duct static pressure classification of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above the scheduled duct static pressure classification.

7. Give ten days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.

2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.

3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.

2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, filters and filter sections, and condensate collectors and drains.

4. Coils and related components.

5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.

6. Supply-air ducts, dampers, actuators, and turning vanes.

7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.

4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.9 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

A. Fabricate ducts as indicated in the following schedule:

B. Duct static pressure classification means static pressure classification in the SMACNA HVAC Duct Construction Standards Metal and Flexible.

C. The column titled “SMACNA Leakage Classification” the designation 4 (2) means the “4” the leakage classification for rectangular duct and “(2)” the leakage classification for round ducts.

DUCT SCHEDULE					
DUCT SYSTEM	SMACNA DUCT CONSTRUCTION STATIC PRESSURE CLASSIFICATION	SMACNA SEAL CLASSIFICATION	SMACNA LEAKAGE CLASSIFICATION	DUCT MATERIAL	REMARKS
Constant Volume Supply Ducts from Fan Discharge to Terminal Box	+3" WG	A	4(2)	Galvanized Sheet Metal	
Constant Volume Supply Ducts from Fan Discharge to Air Distribution Devices Risers	+2" WG +3” WG	A A	8(4) 4(2)	Galvanized Sheet Metal	See Field Quality Control sub-paragraph for leakage test requirement
Constant Volume Supply Ducts from Fan Discharge to Air Distribution Devices	+3" WG	A	4(2)	Galvanized Sheet Metal	Riser Testing
Fan Coil Units, Terminal Boxes, etc. Supply Ducts	+2" WG	A	8(4)	Galvanized Sheet Metal	See Field Quality Control sub-paragraph for leakage test requirement
Fan Coil Units, Terminal Boxes, etc. Return Ducts	-2" WG	A	8(4)	Galvanized Sheet Metal	See Field Quality Control sub-paragraph for leakage test requirement

DUCT SCHEDULE					
DUCT SYSTEM	SMACNA DUCT CONSTRUCTION STATIC PRESSURE CLASSIFICATION	SMACNA SEAL CLASSIFICATION	SMACNA LEAKAGE CLASSIFICATION	DUCT MATERIAL	REMARKS
Return Ducts connected to Air Handling Units or Return Air Fans Riser Duct	-2" WG -3" WG	A A	8(4) 4(2)	Galvanized Sheet Metal	See Field Quality Control sub-paragraph for leakage test requirement
Return Ducts from Terminal Boxes to Air Handling Units or Return Air Fans	-3" WG	A	4(2)	Galvanized Sheet Metal	Riser Testing
Exhaust Ducts connected to Exhaust Fans	-2" WG	A	8(4)	Galvanized Sheet Metal	See Field Quality Control sub-paragraph for leakage test requirements
Dryer & Toilets Exhaust System (Brach Ducts)	-2" WG	A	8(4)	Galvanized Sheet Metal Aluminum	Duct leakage Test required for this system

D. Intermediate Reinforcement:

1. Galvanized-Steel Ducts.

2. Stainless-Steel Ducts:

   a. Exposed to Airstream: Match duct material.

   b. Not Exposed to Airstream: Match duct material.

3. Aluminum Ducts: Aluminum radius type elbow RE-1 or RE-3 shall be used in lieu of mitered RE-2 except where physical constraints do not permit radius type elbow.

E. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 700 fpm (3.5 m/s) or Lower:

(1) Radius Type RE 1 with minimum 0.5 radius-to-duct width ratio.

(2) Square Throat Elbow Type RE 4 without vanes.

b. Velocity 700 fpm to 1500 fpm (3.5 to 7.6 m/s):

(1) Radius Type RE 3 with minimum 1.0 radius-to-duct width ratio and two vanes.

(2) Square Throat Elbow Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm (7.6 m/s) or Higher:

(1) Radius Type RE 1 with minimum 1.5 radius-to-duct width ratio.

(2) Radius Type RE 3 with minimum 1.0 radius-to-duct width ratio and two vanes.

(3) Square Throat Elbow Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

(1) Velocity 1000 fpm (5 m/s) or Lower: 0.6 radius-to-diameter ratio and three segments for 90-degree elbow.

(2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

(3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.

b. Round Elbows, 12 Inches (305 mm) and Smaller in Diameter: Stamped or pleated.

c. Round Elbows, 14 Inches (356 mm) and Larger in Diameter: Standing seam

F. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

   a. Rectangular Main to Rectangular Branch: 45-degree entry.

   b. Rectangular Main to Round Branch: Spin in.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

   a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.

   b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.

   c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.

END OF SECTION 23 31 13

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SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Flange connectors.
4. Duct silencers.
5. Turning vanes.
6. Remote damper operators.
7. Duct-mounted access doors.
8. Flexible connectors.
9. Flexible ducts.
10. Duct accessory hardware.

B. Related Requirements:

1. Section 233723 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

2. Product Data for Prerequisite EA 2: Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.

b. Manual volume damper installations.

c. Control-damper installations.

d. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90 (Z275).

2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts No. 4 and finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS AND COUNTERBALANCE BACKDRAFT DAMPER

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Air Balance Inc.; a division of Mestek, Inc.

2. American Warming and Ventilating; a division of Mestek, Inc.

3. Cesco Products; a division of Mestek, Inc.

4. Greenheck Fan Corporation.

5. Lloyd Industries, Inc.

6. Nailor Industries Inc.

7. NCA Manufacturing, Inc.

8. Pottorff.

9. Ruskin Company.

10. Vent Products Company, Inc.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm (10 m/s).

D. Maximum System Pressure: 1-inch wg (0.25 kPa) 2-inch wg (0.5 kPa).

E. Frame: Hat-shaped, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel or 0.063-inch- (1.6-mm-) thick extruded aluminum, with welded corners or mechanically attachedand mounting flange.

F. Blades: Multiple single-piece blades, maximum 6-inch (150-mm) width, 0.025-inch- (0.6-mm-) thick, roll-formed aluminum with sealed edges or 28 gauge roll-formed galvanized steel. Dampers located in perimeter walls or fans located outdoors shall be aluminum construction.

G. Blade Action: Parallel.

H. Blade Seals: Extruded vinyl, mechanically locked.

I. Blade Axles:

1. Material: Galvanized steel, Stainless steel or Aluminum.

J. Tie Bars and Brackets: Aluminum or Galvanized steel.

K. Return Spring: Adjustable tension.

L. Bearings: Synthetic pivot bushings.

M. Accessories:

1. Adjustment device to permit setting for varying differential static pressure (for pressure relief dampers only).

2. Counterweights and spring-assist kits for vertical airflow installations.

3. Screen Mounting: Rear mounted.

4. Screen Material: Aluminum (For dampers mounted in perimeter walls only).

5. Screen Type: Insect.

6. 90-degree stops.

7. Mounting: Dampers shall be suitable for horizontal air (up/down) flow and vertical air flow.

N. For dampers located at fan discharge, mount dampers a minimum of one half fan diameter downstream of fan discharge.

O. Counterbalanced backdraft dampers shall be as described above except that damper blades shall be equipped with adjustable weights mechanically attached to blades.

2.4 MANUAL VOLUME DAMPERS

A. At the Contractor's option, shop fabricated manual volume damper maybe used in lieu of manufactured manual volume dampers. Manual volume damper shall be constructed in accordance with the requirements in SMACNA HVAC Duct Construction Standards – Metal and Flexible Manual Chapter 7. Where Contact Drawing designated "low leakage manual volume dampers", only test and rated manufactured dampers shall be used.

B. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Air Balance Inc.; a division of Mestek, Inc.

    b. American Warming and Ventilating; a division of Mestek, Inc.

    c. Flexmaster U.S.A., Inc.

    d. McGill AirFlow LLC.

    e. Nailor Industries Inc.

    f. Pottorff.

    g. Ruskin Company.

    h. Trox USA Inc.

    i. Vent Products Company, Inc.

2. Standard leakage rating.

3. Suitable for horizontal or vertical applications.

4. Frames:

    a. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel or 0.05-inch- (1.3-mm-) thick stainless steel.

    b. Material shall be compatible with duct construction (galvanized, stainless or aluminum).

    c. Mitered and welded corners.

    d. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

    a. Multiple or single blade.

    b. Parallel- or opposed-blade design.

    c. Stiffen damper blades for stability.

    d. Galvanized or Stainless-steel, 0.064 inch (1.62 mm) thick. Material shall be compatible with duct construction (galvanized, stainless or aluminum).

    e. Blade Axles: Galvanized steel or Stainless steel. Material shall be compatible with duct construction (galvanized, stainless or aluminum).

6. Bearings:

   a. Molded synthetic or Stainless Steel sleeve.

   b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

7. Tie Bars and Brackets: Galvanized steel or stainless steel. Material shall be compatible with duct construction (galvanized, stainless or aluminum).

8. Each damper shall include a locking device to hold damper in fixed (balanced) position without vibration.

9. Dampers in insulated duct systems shall include elevated duct platform suitable for insulated ducts.

C. Standard, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Air Balance Inc.; a division of Mestek, Inc.

   b. American Warming and Ventilating; a division of Mestek, Inc.

   c. McGill AirFlow LLC.

   d. Nailor Industries Inc.

   e. Pottorff.

   f. Ruskin Company.

   g. Trox USA Inc.

   h. Vent Products Company, Inc.

2. Standard leakage rating.

3. Suitable for horizontal or vertical applications.

4. Frames: Hat-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

   a. Multiple or single blade.

   b. Parallel- or opposed-blade design.

   c. Stiffen damper blades for stability.

d. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.

e. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.

6. Blade Axles: Nonferrous metal.

7. Bearings:

a. Molded synthetic or Stainless-steel sleeve.

b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Aluminum.

9. Each damper shall include a locking device to hold damper in fixed (balanced) position without vibration.

10. Dampers in insulated duct systems shall include elevated duct platform suitable for insulated ducts.

D. Low-Leakage, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Air Balance Inc.; a division of Mestek, Inc.

b. American Warming and Ventilating; a division of Mestek, Inc.

c. McGill AirFlow LLC.

d. Nailor Industries Inc.

e. Pottorff.

f. Ruskin Company.

g. Trox USA Inc.

h. Vent Products Company, Inc.

2. Comply with AMCA 500-D testing for damper rating.

3. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

4. Suitable for horizontal or vertical applications.

5. Frames:

a. Hat or U shaped.

b. 0.094-inch- (2.4-mm-) thick, galvanized sheet steel 0.05-inch- (1.3-mm-) thick stainless steel. Material shall be compatible with duct construction (galvanized, stainless or aluminum).

c. Mitered and welded corners.

d. Flanges for attaching to walls and flangeless frames for installing in ducts.

6. Blades:

a. Multiple or single blade.

b. Parallel- or opposed-blade design.

c. Stiffen damper blades for stability.

d. Galvanized or Stainless, roll-formed steel, 0.064 inch (1.62 mm) thick. Material shall be compatible with duct construction (galvanized, stainless or aluminum).

7. Blade Axles: Galvanized steel or Stainless steel. Material shall be compatible with duct construction (galvanized, stainless or aluminum).

8. Bearings:

a. Molded synthetic or Stainless-steel sleeve.

b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

9. Blade Seals: Neoprene.

10. Jamb Seals: Cambered. Material shall be compatible with duct construction (galvanized, stainless or aluminum).

11. Tie Bars and Brackets: Galvanized steel or Stainless Steel. Material shall be compatible with duct construction (galvanized, stainless or aluminum).

12. Accessories:

a. Include locking device to hold damper in a fixed (balanced) position without vibration.

b. Dampers in insulated duct systems shall include elevated duct platform suitable for insulated ducts.

E. Low-Leakage, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Air Balance Inc.; a division of Mestek, Inc.

b. American Warming and Ventilating; a division of Mestek, Inc.

c. McGill AirFlow LLC.

d. Nailor Industries Inc.

e. Pottorff.

f. Ruskin Company.

g. Trox USA Inc.

h. Vent Products Company, Inc.

2. Comply with AMCA 500-D testing for damper rating.

3. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

4. Suitable for horizontal or vertical applications.

5. Frames: Hat or U shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.

6. Blades:

   a. Multiple or single blade.

   b. Parallel- or opposed-blade design.

   c. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.

   d. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.

7. Blade Axles: Nonferrous metal.

8. Bearings:

   a. Molded synthetic.

   b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

9. Blade Seals: Neoprene.

10. Jamb Seals: Cambered. Material shall be compatible with duct construction (galvanized, stainless or aluminum).

11. Tie Bars and Brackets: Aluminum.

12. Accessories:

    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

F. Jackshaft:

1. Size: 0.5-inch (13-mm) 1-inch (25-mm) diameter.

2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

G. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut.

2. Include center hole to suit damper operating-rod size.

3. Include elevated platform for insulated duct mounting.

2.5 FLANGE CONNECTORS (IF REQUIRED)

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Ductmate Industries, Inc.

2. Nexus PDQ; Division of Shilco Holdings Inc.

3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

C. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

D. Material: Galvanized steel.

E. Gage and Shape: Match connecting ductwork.

2.6 DUCT SILENCERS (IF REQUIRED)

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Dynasonics.
2. Industrial Noise Control, Inc.
3. McGill AirFlow LLC.
4. Ruskin Company.
5. Vibro-Acoustics.
6. Industrial Acoustic Company (IAC) America.

C. General Requirements:

1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
4. Duct silencers shall be constructed not to structurally fail when subject to a differential pressure of 6 inches Water Gauge from inside to outside casing. Where duct systems with duct pressure classification as specified in Section 23 31 13 titled Metal Ducts exceeds 6 inches, duct silencers shall be designed not to structurally fail when subject to a differential pressure equal to the duct pressure classification of the system.

D. Shape:

1. Rectangular straight with splitters or baffles.
2. Round straight with center bodies or pods.
3. Rectangular elbow with splitters or baffles.
4. Round elbow with center bodies or pods.
5. Rectangular transitional with splitters or baffles.

E. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G90 (Z275), galvanized sheet steel, 0.034 inch (0.85 mm) 0.040 inch (1.02 mm) thick. Materials for construction of duct silencers mounted in aluminum or stainless steel duct systems shall be of the same materials as duct system and equivalent thickness.

F. Round Silencer Outer Casing: ASTM A 653/A 653M, G90 (Z275), galvanized sheet steel. Materials for construction of duct silencers mounted in aluminum or stainless steel duct systems shall be of the same materials as duct system and equivalent thickness.

1. Sheet Metal Thickness for Units up to 24 Inches (600 mm) in Diameter: 0.034 inch (0.85 mm) thick.

2. Sheet Metal Thickness for Units 26 through 40 Inches (660 through 1000 mm) in Diameter: 0.040 inch (1.02 mm) thick.

3. Sheet Metal Thickness for Units 42 through 52 Inches (1060 through 1300 mm) in Diameter: 0.05 inch (1.3 mm) thick.

4. Sheet Metal Thickness for Units 54 through 60 Inches (1370 through 1500 mm) in Diameter: 0.064 inch (1.62 mm) thick.

G. Inner Casing and Baffles: ASTM A 653/A 653M, G90 (Z275) galvanized sheet metal, 0.034 inch (0.85 mm) thick, and with 1/8-inch- (3-mm-) diameter perforations. Materials for construction of duct silencers mounted in aluminum or stainless steel duct systems shall be of the same materials as duct system and equivalent thickness.

H. Special Construction:

1. Suitable for outdoor use.

2. High transmission loss to achieve STC 45.

I. Connection Sizes: Match connecting ductwork unless otherwise indicated.

J. Principal Sound-Absorbing Mechanism:

1. Controlled impedance membranes and broadly tuned resonators without absorptive media where drawings call for Packless Duct Silencers.

2. Dissipative,Film-lined type with fill material.

a. Fill Material: Inert, vermin-proof and moisture-proof fibrous material, packed under not less than 5 percent compression.

b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.

3. Lining: None OR Tedlar.

K. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.

1. Joints: flanged connections.

2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.

3. Reinforcement: Cross or trapeze angles for rigid suspension.

L. Accessories:

1. Factory-installed end caps to prevent contamination during shipping.

2. Removable splitters.

M. Source Quality Control: Test according to ASTM E 477.

1. Testing of mockups to be witnessed by Owner.

2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm (10-m/s) face velocity.

3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg (1500-Pa) static pressure, whichever is greater.

N. Capacities and Characteristics:

1. See Duct Silencer (Sound Attenuator) schedule on drawings for capacities and characteristics

2.7 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Ductmate Industries, Inc.

2. Duro Dyne Inc.

3. Elgen Manufacturing.

4. METALAIRE, Inc.

5. SEMCO Incorporated.

6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Single wall construction with a 4½ Inches (114 mm) radius and spaced at 3¼ Inches (83 mm) as defined in SMACNA. Double wall construction with a 4½ Inches (114 mm) radius and spaced 3¼ Inches (83 mm) as defined in SMACNA. Turning vanes shall be welded to runners. Runners for turning vanes shall be secured to the duct so that they do not generate noise or vibration. Runners for turning vanes in duct where the duct velocity exceeds 1,500 FPM, runner welded to the duct.

F. Vane Construction: Single walled turning vanes shall be used in all ducts with velocities or 2.300 FPM or less. Double walled turning vanes shall be used in all duct system with duct velocity in excess of 2,200 FPM. Construction for turning vanes shall be as defined in SMACNA's HVAC Duct Construction Standards – Metal and Flexible Chapter 4 except that the maximum unsupported length for single thickness shall be 24 Inches (605 mm) and a maximum unsupported length for double thickness shall be 30 Inches (755 mm).

2.8 REMOTE DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Pottorff.

2. Ventfabrics, Inc.

3. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass, Copper or Aluminum.

D. Cable: Stainless steel.

E. Wall-Box Mounting: Recessed.

F. Wall-Box Cover-Plate Material: Stainless steel.

2.9 DUCT-MOUNTED ACCESS DOORS

A. At the Contractor's option, shop fabricated access doors maybe used in lieu of manufactured access doors. Access doors shall be constructed in accordance with the requirements in SMACNA HVAC Duct Construction Standards – Metal and Flexible Manual Chapter 7. Where Contact Drawing designated "pressure relief access doors, only test and rated manufactured access doors shall be used.Manufacturers: Subject to compliance with requirements, provide products by the following:

1. American Warming and Ventilating; a division of Mestek, Inc.

2. Cesco Products; a division of Mestek, Inc.

3. Ductmate Industries, Inc.

4. Elgen Manufacturing.

5. Flexmaster U.S.A., Inc.

6. Greenheck Fan Corporation.

7. McGill AirFlow LLC.

8. Nailor Industries Inc.

9. Pottorff.

10. Ventfabrics, Inc.

11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

C. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

a. Double wall, rectangular.

b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.

c. Vision panel. (24 x 48 inch and large access doors only)

d. Hinges and Latches: 1-by-1-inch (25-by-25-mm)butt or piano hinge and cam latches.

e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.

b. Access Doors up to 18 Inches (460 mm) Square: Two hinges, Continuous, and two sash locks.

c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Three hinges, Continuous, and two compression latches with outside and inside handles.

d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): Four hinges, Continuous, and two compression latches with outside and inside handles.

2.10 DUCT ACCESS PANEL ASSEMBLIES (IF REQUIRED)

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Ductmate Industries, Inc.

2. Flame Gard, Inc.

3. 3M.

C. Labeled according to UL 1978 by an NRTL.

D. Panel and Frame: Minimum thickness 0.060-inch (1.5-mm) Stainless Steel (thickness equivalent to carbon steel for duct pressure class).

E. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.

F. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F (1093 deg C).

G. Minimum Pressure Rating: 10-inch wg (2500 Pa), positive or negative.

2.11 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Ductmate Industries, Inc.

2. Duro Dyne Inc.

3. Elgen Manufacturing.

4. Ventfabrics, Inc.

5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 12 inches (300 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).

2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.

3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).

2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.

3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.

2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch (6-mm) movement at start and stop.

2.12 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Flexmaster U.S.A., Inc.

2. McGill AirFlow LLC.

3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Insulated Flexible Duct with Vapor Barrier

1. UL 181, Class 1

2. Mechanical interlocking spiral aluminum with circumferential corrugation for strength and flexibility (adhesives not permitted)

3. Fibrous-glass insulation with a minimum thermal resistance (R) equal to 8

4. Factory applied vapor barrier with a permeance of 0.05 Perms (ASTM E 96-66 Procedure A)

5. Flame/Smoke 25/50

6. Maximum Duct Velocity 5,500 FPM

7. Pressure rating Positive 10" w.g. through 16" diameter, 6" w.g. 18" & 20"; Negative 12" w.g. through 16" diameter, 4" w.g. 18" & 20" diameter

8. Minimum bend diameter 1.5 duct diameter.

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 20 inches (75 through 500 mm), to suit duct size.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft and control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. If the location of manual balancing damper is not defined on the drawing the following minimum standards for supply, return and exhaust shall govern:

1. Main ducts from trunk ducts

2. Branch ducts from main ducts

3. Sub-branch ducts from branch ducts

4. Sub-sub branch ducts from sub-branch.

5. Locate dampers as far as possible from air outlets to avoid noise transmission.

E. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.
3. Install stainless steel volume dampers in stainless steel ducts.

F. Set dampers to fully open position before testing, adjusting, and balancing.

G. Install test holes at fan inlets and outlets and elsewhere as indicated.

H. Connect ducts to duct silencers rigidly.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream and downstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from control dampers, backdraft dampers, and equipment.
6. At each change in direction and at maximum 50-foot (15-m) spacing.
7. Upstream and downstream from turning vanes.
8. Upstream or downstream from duct silencers.
9. Control devices requiring inspection.
10. Upstream and downstream of air flow stations
11. Upstream and/or downstream of equipment requiring of equipment service.
12. Sheet metal plenums (two required on opposite sides of plenum.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
3. Head and Hand Access: 24 by 10 inches (600 by 250 mm).
4. Head and Shoulders Access: 24 by 14 inches (600 by 355 mm).

5. Body Access: 24 by 48 inches (600 by 1200 mm).

L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. Connect terminal units to supply ducts directly or with maximum 12-inch (300-mm) lengths of flexible duct. Do not use flexible ducts to change directions.

O. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch (1500-mm) lengths of flexible duct clamped in place. If the length of flexible duct (60 inches) exceeds allowable length by local jurisdiction, local jurisdiction governs.

P. Connect flexible ducts to metal ducts with clamps as described in a previous paragraph in this section.

Q. Install duct test holes where required for testing and balancing purposes.

R. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop of fans.

3.2 CONTROL DAMPERS

A. Control dampers will be furnished as part of the work Section of this specification. This Contractor shall install Control Dampers.

B. Coordinate with Control Contractor size and location of control dampers.

3.3 FLEXIBLE CONNECTIONS

A. All fan and air supply unit connections, both at inlet and discharge shall be made with flexible material so as to prohibit the transfer of vibration from fans to ductwork connecting thereto, without air leakage. The material between the clamps shall have sufficient slack so as to prevent tearing due to fan movement.

B. The flexible connections shall be a minimum of 12" long and held in place with heavy metal bands, securely attached, to prevent any leakage at the connection points.

C. Flexible connections shall be fabricated from approved flame proofed fabric conforming to 90A of the N.F.P.A. Asbestos cloth is not permitted.

DAMPER (CONTROL, SMOKE & FIRE/SMOKE) ASSIGNMENT SCHEDULE					
SYSTEM COMPONENTS	FURNISHED BY	INSTALLED BY	POWER CONTROL WIRING BY	CONTROL WIRING BY	REMARKS
Control Dampers required as part of an HVAC System	Controls Contractor	HVAC Contractor	Controls Contractor	Controls Contractor	Actuators provided by Controls Contractor

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that purpose of access door can be performed.

3. Inspect turning vanes for proper and secure installation.

4. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

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SECTION 23 34 23 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Utility set fans.
2. Ceiling-mounted ventilators.
3. In-line centrifugal fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level for projects at elevations 1,000 feet or lower.

B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolatorsand for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Roof framing and support members relative to duct penetrations.
2. Ceiling suspension assembly members.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set(s) for each belt-driven unit.

1.8 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705.

1.9 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 FANS - GENERAL

A. Fans shall be of the types and capacities listed in the Schedules on the Contract Documents and as specified herein.

B. Fan performance shall be based on tests conducted in accordance with ASHRAE 51 and AMCA Standard Test Code for Centrifugal and Axial Fans and fans shall bear the AMCA Certified Ratings Seal for Sound and Air Performance.

C. Fan shall be listed by Underwriters Laboratories (UL/cUL 705) for US and Canada.

D. Centrifugal fans to be non-over-loading having a sharply rising pressure characteristic which will extend throughout the operating range and continue to rise well beyond the efficiency peak to ensure quiet, stable operation under all conditions. The horsepower characteristic shall be truly self-limiting and shall reach a peak in the normal selection area. Unit shall be of manufacture as noted on drawings, or approved. Submit sound power ratings for approval.

E. Fans shall be provided with mechanical brake, coordinate with BMS.

F. Fans shall be statically and dynamically balanced at the factory prior to shipment. Fans shall be balanced for inverter duty operation (VFC). The fan will be balanced over the entire range of fan operation (30% to 100% of RPM). Filter-in measurements shall not exceed 5 mils in the horizontal and vertical planes. Filter-out measurements shall not exceed 7.5 mils in the horizontal, vertical and axial planes. The maximum allowable RMS velocity at maximum fan class speed measured at each bearing shall not exceed 0.09 inches/sec. All fans 10,000 CFM and larger shall have factory balancing certified in writing. Certification shall be submitted prior to shipment of fans.

G. Fan shall be minimum Class I construction with proper UL label. Fan Class shall be as scheduled on the drawings.

H. The specified fan RPM, outlet velocity, and trip speed are the maximum acceptable. The motor horsepower, CFM, and static pressure are the minimum acceptable.

I. Unless noted otherwise by specific fan type housing, fan housing shall be heavy gauge continuous welded steel construction with fan scroll and bearings supported from structural steel framework.

J. Fan housing shall be of suitable thickness and bracing required for stable and rigid construction, with no deflection, and to prevent vibration and pulsation.

K. Provide inlet screens for all fans, constructed for easy removal, manufacturer of heavy wire mesh.

L. Fans having duct-connected inlets shall be provided with a flanged inlet and/or outlet collar matching companion flange.

M. For exterior mounted fans, a weatherproof housing shall be provided with ventilation grilles to cover motor and drive assembly.

N. Provide birdscreen on fans exposed to the environment.

O. Provide adequate space for service of fan, motor and bearings.

P. The fan shaft shall be solid steel, accurately turned, ground and polished, and ring gauged for accuracy.

Q. Recommended bearing manufacturer tolerances must be met in the contact area for bearings.

R. Shafts must be dial indicator inspected for straightness after the keys are cut.

S. Fan shaft shall be coated with rust inhibitive coating.

T. Fan wheel assembly or propeller assembly shall be statically and dynamically balanced prior to fan assembly.

U. The entire rotating assembly shall be designed so the first critical speed is a minimum of 25% greater than the max class fan speed.

V. Fan Shaft Bearings/Sheave

1. Fan bearings shall be foot-mounted type, bolted on a rigid welded steel framework integral with the housing.
2. Bearings shall be designed and individually tested specifically for use in air handling applications.
3. Bearings shall be sized for a minimum L-10 life of 200,000 hours at maximum fan class operating conditions including belt pull, unless noted otherwise. Bearings shall be selected in accordance with standards set forth by the Anti-Friction Bearing Mfrs. Assn. (AFBMA).
4. Bearings shall be double-row spherical, self-aligning, grease lubricated, roller bearings housed in a horizontally split pillow block housing.
5. Where bearings are not easily accessible or motor is installed in airstream, provide stable, accessible clear plastic grease leads to a common location.
6. Fan sheave shall be of the non-adjustable type and machined on all surfaces Fan sheave shall be statically and dynamically balanced. If weights are required for balancing, weights shall be welded to sheave. Fan sheave shall have tapered lock, split and keyed to hub.
7. Replacement Fan sheaves: provide additional fan sheaves as required for balancing at no additional cost to the owner.

W. Fan Motor and Drive

1. Motors shall meet requirements as specified under another section of Division 23 work titled "Common Motor Requirements for HVAC Equipment".
2. Fan drive shall be a multiple V-belt type sized for 1.65 times the fan motor horsepower, unless noted otherwise.
3. Provide balanced variable sheaves for motors 60 HP and under. Size variable sheaves at midpoint of specified operating conditions to allow field adjustment up or down during balancing procedures.

4. V-Belt Drives: The fans are to be driven with V-belt drive, of ample capacity sized for 1.65 x motor HP. Motor sheaves shall be adjustable ratio type; they shall be sized to give the required fan speed with motor sheave at about the middle of its range of adjustment. Motor sheave adjustment range shall be selected for the rated fan RPM as determined by fan capacity requirements scheduled on the drawings and adjustable to fifteen (15%) percent above and below the rated fan speed. There shall be at least two (2) belts; and drive capable of carrying the entire load with an additional 50% safety factor. Belt guards with opening for RPM readings to be provided for all sheaves and belts. Submit drive data for approval. If the fan capacity with scheduled fan speed is below design, change sheave and adjust as required to meet design capacity.
5. Some fans will be furnished with ECMs as indicated in the Contract Documents. T
6. Each motor for a belt driven fan shall be factory mounted on an adjustable base rigidly supported on the fan and shall have extended shaft to accommodate the adjustable pitch sheaves.
7. Motor shall be 1800 rpm maximum for belt driven or direct drive fans.
8. An OSHA approved type fan drive belt guard shall be provided with provision for RPM measurement at both motor and fan without removing the guard. The guard shall be made of ½" 16 gauge flattened expanded steel, wrapped around a 16 gauge channel frame suitably braced to prevent vibration. Guard shall be G-90 galvanized with coating same as fan.
9. Fan belts shall be oil resistant 24,000 hour non-sparking, non-static belts. For fans ½ HP and larger, quantity of belts shall be such that if one belt fails, remaining belts shall allow for fan to continue to functioning as designed.

X. Sound Rating:

1. Fan sound ratings shall be based on AMCA 300 tests in a sound laboratory reverberant room. Data must be based on RSS calibration within last six (6) months. Separate data must be provided for both inlet and outlet.
2. Where the manufacturer's sound power data is not published, an officer of the company must certify that sound data conforms with the requirements specified under another section of this work. If the manufacturer does not have acoustical facilities in accordance with the above requirements, the contractor must submit certified data that the specified units have been tested in an approved independent acoustics lab, capable of testing equipment at specified operating conditions to determine sound power levels by octave band.
3. Where units do not meet the above requirements, the Subcontractor must furnish at no additional cost, necessary attenuation to reduce net sound level to the above requirements. In this case, the room sound level must be taken by the Subcontractor and

submitted for approval by the Engineer to assure conformance to sound level requirements.

4. The increase pressure drop due to attenuation must not cause and increase in power requirements from those specified. If oversized, slow speed fan is required, this Contractor shall be responsible for any related extra costs from other trades to accommodate change in fan.

Y. Provide thrust arrestors as required to limit movement of the fan upon start-up.

Z. Manufacturer shall provide heavy gauge windband constructed of bolted steel with reinforced edges and bolted seams and butterfly damper constructed of heavy gauge aluminum with field-replaceable neoprene seals, as required.

AA. Provide riveted, engraved aluminum nameplate containing pertinent, specific fan data, including manufacturer, model, serial number, etc.

BB. Roof mounted fans and fans exposed to the weather shall have all fan parts clean and prime painted prior to final assembly. Fan wheels and housing shall be provided with two coats of corrosion resistance epoxy paint after final assembly.

2.2 UTILITY SET FANS

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

1. Aerovent; a division of Twin City Fan Companies, Ltd.
2. Loren Cook Company.
3. Greenheck Fan Co..

B. Housing: Fabricated of galvanized steel with side sheets fastened with a deep lock seam or welded to scroll sheets.

1. Housing Discharge Arrangement: Adjustable to eight standard positions.
2. Fan type AMCA arrangement 10 with a single width and single inlet housing.
3. Housing and bearing supports shall be constructed of welded steel members to prevent vibration and to rigidly support the shaft and bearing assembly
4. Housing support constructed of structural steel with formed flanges
5. Drive frame is welded steel that supports the shaft and bearing and reinforcement for the housing
6. Pivoting motor plate with adjusting screws for belt tensioning.
7. Finish as described in previous sub-paragraph titled “Fans – General” above.

C. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.

1. Blade Materials: Steel or Aluminum.
2. Blade Type: Backward inclined or Airfoil as scheduled on drawings.
3. Non-overloading centrifugal wheel; rotation as determined by layout on drawings
4. Single thickness blades securely riveted or welded to heavy gauge blackplate and wheel cone

5. Wheel cone and fan inlet matched and shall have close running tolerances for maximum performance and operating efficiency
6. Statically and dynamically balanced in accordance with AMCA Standard 204-05
7. Spark-Resistant Construction: AMCA 99, Type as scheduled on drawings.

D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

1. Fan Pulley: For requirements, see previous sub-paragraph titled "Fan – General above

E. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L_{10} of 80,000 hours.

1. Extend grease fitting to accessible location outside of unit.

F. Belt Drives:

1. Factory mounted, with final alignment and belt adjustment made after installation
2. Motor Pulleys: For requirements, see previous sub-paragraph titled "Fans – General" above.
3. Belts: For requirements, see previous sub-paragraph titled "Fans – General" above.
4. Belt Guards: For requirements, see previous sub-paragraph titled "Fans – General" above.

G. For motor requirements see Division 23 Section titled "Common Motor Requirements for HVAC Equipment"

H. Accessories:

1. Inlet and Outlet: Flanged.
2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
3. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades with felt edges in steel frame installed on fan discharge.
4. Access Door: Gasketed door in scroll with latch-type handles.
5. Inlet Screens: Removable wire mesh.
6. Drain Connections: NPS 3/4 (DN 20) threaded coupling drain connection installed at lowest point of housing with drain valve.
7. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
8. Discharge Dampers: Assembly with parallel blades constructed of two plates formed around and to shaft, channel frame, sealed ball bearings, with blades linked outside of airstream to single control lever of same material as housing.
9. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
10. Heat Slinger to dissipate heat along fan shaft
11. Shaft seal on rub ring to seal shaft

I. Capacities and Characteristics:

1. See schedule on drawings for fan requirements.

2.3 CEILING-MOUNTED VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
2. Loren Cook Company.

B. Housing: Steel, lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

D. Grille: Aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
4. Motion Sensor: Motion detector with adjustable shutoff timer.
5. Filter: Washable aluminum to fit between fan and grille.
6. Isolation: Rubber-in-shear vibration isolators.
7. Manufacturer's standard roof jack or wall cap, and transition fittings.

G. Capacities and Characteristics:

1. See schedule on drawings for fan requirements.

2.4 IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
2. Loren Cook Company.

B. General Description:

1. Base fan performance at standard conditions (density 0.075 Lb/ft3).
2. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.
3. Fan design for straight thru flow.

C. Wheel:

1. Non-overloading, backward inclined centrifugal wheel.
2. Constructed of aluminum.
3. Satically and dynamically balanced in accordance to AMCA Standard 204-05.
4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.
5. Single thickness blades are securely riveted or welded to a heavy gauge back plate and wheel cone.
6. Direct drive fan wheel direct connected to motor.

D. Motors:

1. Motor: For motor requirements, see Division 23 Section titled "Common motor Requirements for HVAC Equipment.
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. Totally enclosed air over (TEAO) Totally enclosed fan cooled (TEAC).

E. Shafts and Bearings:

1. Fan shaft shall be ground and polished solid steel with an anti corrosive coating.
2. Permanently sealed bearings or pillow block ball bearings.
3. Bearing shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
4. Fan Shaft first critical speed is at least 25 percent over maximum operating speed.

F. Housing/Cabinet Construction

1. Square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars
2. Housing and bearing supports shall be constructed of heavy gauge bolted and welded steel construction to prevent vibration and to rigidly support the shaft and bearing assembly.

G. Housing Supports and Drive Frame:

1. Housing supports are constructed of structural steel with formed flanges.
2. Drive frame is welded steel which supports the shaft and bearings and reinforcement for the housing.
3. Pivoting motor plate with adjusting screws to make belt tensioning operations.

H. Disconnect Switches:
1. NEMA rated: 1 3R
2. Positive electrical shut-off.
3. Wired from fan motor to junction box installed within motor compartment.
4. Nonfusible type with thermal overload protection mounted on the fan housing.

I. Drive Assembly:

1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower. For requirements, see previous sub-paragraph titled "Fans – General" above.
2. Belts: Static free and oil resistant. For requirements, see previous sub-paragraph titled "Fans – General" above.
3. Pulleys: Cast type, keyed, and securely attached to wheel and motor shafts. For requirements, see previous sub-paragraph titled "Fans – General" above.
4. Motor pulleys are adjustable for final system balancing. For requirements, see previous sub-paragraph titled "Fans – General" above.
5. Readily accessible for maintenance.

J. Duct Collars:

1. Square design to provide a large discharge area.
2. Inlet and discharge collars provide easy duct connection.

K. Access Panel:

1. Two sided access panels, permit easy access to all internal components.
2. Located perpendicular to the motor mounting panel.

L. Accessories:

1. Belt Guards:

    a. For requirements, see previous sub-paragraph titled "Fans – General" above.

2. Dampers:

    a. Types: Gravity Motorized.
    b. Galvanized frames with prepunched mounting holes.

3. Extended Lube Lines:

    a. Grease zerks on housing exterior allows for lubrication of bearings without disassembling the fan.

4. Finishes:

    a. Coating type: Manufacturer's standard coating.

5. Inlet and Outlet Guards:

    a. Constructed of expanded metal mounted in a steel frame to provide protection for non-ducted installations.

6. Insulated Housing

   a. Thickness: 1 inches.
   b. For acoustical liner requirements see Division 23 Section titled “Metal Ducts”.

7. Motor Cover:

   a. Constructed of galvanized steel.

8. Wiring Pigtail:

   a. Direct hook-up to the power supply.
   b. Nine foot wiring extension.

9. Companion Planges

   a. inlet and outlet duct connections.

10. Variable speed Controller (direct drive fans only).

11. Fan Housing aluminum construction in lieu of galvanized sheet metal.

M. Capacities and Characteristics:

1. See schedule on drawings for fan requirements.

N. Accessories:

1. Gravity Shutters: Aluminum blades in aluminum frame; interlocked blades with nylon bearings.
2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
3. Wall Sleeve: Galvanized steel to match fan and accessory size.
4. Weathershield Hood: Galvanized steel to match fan and accessory size.
5. Weathershield Front Guard: Galvanized steel with expanded metal screen.
6. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
7. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

O. Capacities and Characteristics:

1. See schedule on drawings for fan requirements.

2.5 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 section titled, "Common Motor Requirements for HVAC Equipment."

1. 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.

B. Enclosure Type: Totally enclosed, fan cooled.

2.6 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using Vibration devices are specified in vibration section of Division 23.

1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Install floor-mounted units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

D. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Division 7, titled "Roof Accessories" for installation of roof curbs.

E. Support suspended units from structure using threaded steel rods and vibration-control devices are specified in vibration section of Division 23.

F. Install units with clearances for service and maintenance.

G. Label units according to requirements specified in Division 23 Section titled, "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23, Section titled, "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26, Section titled "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26, Section titled "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. HVAC Contractor shall perform the following tests and inspections.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Division 23, Section titled "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 23 34 23

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SECTION 23 37 13 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Rectangular and square ceiling diffusers.

2. Linear bar diffusers.

3. Linear slot diffusers.

4. Adjustable bar registers and grilles.

5. Fixed face registers and grilles.

B. Related Sections:

1. Division 23; Section Titled "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 QUALITY ASSURANCE

A. Manufacturers Qualifications: Firms regularly engaged in manufacture of air distribution devices, air outlets and inlets of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. All air distribution equipment shall be designed, manufactured and tested in accordance with the latest applicable industry standards including the following:

1. AHRI Compliance: Test and rate air devices in accordance with AHRI Standards.

2. ANSI/ASHRAE Compliance: Test and rate air devices in accordance with ANSI/ASHRAE Standards.

3. ADC Seal: Provide devices bearing ADC Certified Rating Seal.

4. AMCA Compliance: Test and rate air devices in accordance with AMCA Standards and shall bear AMCA Certified Rating Seal.

5. NFPA Compliance: Install air devices in accordance with NFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems.

6. UL Compliance: The complete device must be labeled and listed by UL and must be installed to meet their requirements.

7. All devices must be tested and approved for safety in accordance with the latest N.E.C.

1.4 ACOUSTICAL SPECIFICATION FOR DIFFUSERS

A. Air Distribution System; Diffusers, Grilles and Register Noise: Maximum permissible sound power levels in octave bands of airborne transmission through the combination of grille, registers, diffusers, or related pressure reducing devices, when operated at the maximum inlet pressure and cfm in installed condition per plans and specifications shall be as follows:

Children Rooms	NC 35
Private Offices	NC 35
Conference Rooms	NC 35
Open Plan Offices	NC 40
Corridors	NC 40
Bathrooms	NC 45
Storage Rooms	NC 45
Kitchen	NC 50

AIR DISTRIBUTION SYSTEM EQUIPMENT/TERMINAL DEVICE NOISE
MAX PWL (dB re 10 12 Watt)

Octave Band	NC 35	NC 40	NC 45	NC 50+
1	62	66	68	70
2	56	60	63	66
3	49	54	58	62
4	46	51	56	61
5	43	48	53	58
6	42	47	52	57
7	41	46	51	56
8	42	47	52	57

1.5 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

1. Manufacturer's technical product data, including performance data for each size and type of air distribution device furnished; schedule showing drawing designation, room location, number furnished, model number, size and accessories furnished and installation and start-up instructions.

2. Data sheet for each type of air outlet and inlet, and accessory furnished, indicating construction, finish and mounting details.

3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

C. Wiring Diagrams: Submit ladder-type wiring diagrams for electric power and control components, clearly indicating required field electrical connections.

D. Maintenance Data: Submit maintenance data and parts list for each type of air terminal, including trouble shooting maintenance guide. Include this data, product data, shop drawings, and maintenance data in maintenance manual, in accordance with requirements of Division 01.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.

2. Method of attaching hangers to building structure.

3. Size and location of initial access modules for acoustical tile.

4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

5. Duct access panels.

B. Source quality-control reports.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver air distribution devices wrapped in factory-fabricated fiber-board type containers. Identify on outside of container type of device and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

B. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors, when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 – PRODUCTS

2.1 DIFFUSERS, REGISTERS AND GRILLES

A. General

1. All grilles, registers, ceiling outlets and floor outlets shall be furnished and installed as shown on the contract documents and as specified herein.

2. All grilles, registers, ceiling outlets and floor outlets shall be similar and approved equal to the types indicated on the Drawings and specified herein

3. Devices shall be aluminum or steel and shall be factory finished with baked white enamel finish or extruded aluminum finish unless otherwise scheduled on the drawings.

4. Equipment manufacturer shall submit engineering data in a manner to facilitate convenient review of the following factors:

   a. Throw, terminal velocity, noise criteria (NC), sound power, static pressure and total pressure of each type and size of air outlet.

   b. Supply air units shall distribute the specified quantity of air evenly throughout the occupied zone uniformly, draftlessly and noiselessly. Sound levels shall not exceed ratings as required in the "Acoustical Treatment" section of these specifications.

   c. For devices installed in plaster construction, supply plaster frames as required for setting.

   d. All design and margin construction shall be coordinated with architectural requirements. Plaster frames where required shall be constructed of same material and finish as air terminal.

   e. The air outlet manufacturer shall review architectural plans and shall be responsible for furnishing all air outlets with frames and margins which will be compatible with ceiling construction.

5. All ceiling diffusers shall be furnished and installed with an equalizing deflector and volume damper.

6. If diffuser is to be used for return air, omit equalizing deflector.

7. Supply diffusers shall be gasketed to prevent streakage, unless installed in T-bar or concealed spline ceiling.

8. Blank-off or sectorizing baffles shall be furnished as indicated.

9. Diffusers shall be aluminum or steel and shall be factory finished with baked acrylic paint finish of color selected by Architect.

10. Diffusers shall be tested and certified in accordance with latest edition of ANSI/ASHRAE Standard 70

2.2 CEILING DIFFUSERS

A. Square Ceiling Diffusers. TITUS MODELS TMS & TMSA

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Anemostat Products; a Mestek company.

   b. Carnes.

   c. Krueger.

   d. METALAIRE, Inc.

   e. Nailor Industries Inc.

   f. Price Industries.

   g. Titus.

   h. Tuttle & Bailey.

2. Material: Steel (24 Gauge), Aluminum (0.040 inches) as scheduled on the drawings

3. Finish: Baked acrylic paint; white for steel air distribution devices, anodized for aluminum or as scheduled on the drawings or other special finish as scheduled on drawings

4. Face Size

   a. Square;

      (i) 24 x 24 inches (600 x 600 mm) (Steel and Aluminum)

      (ii) 12 x 12 inches (300 x 300 mm) (Steel only)

5. Face Style: Three cones: One fixed cone; two adjustable cones (two adjustable cones shall include adjustable vanes to allow flow pattern from fully horizontal to fully vertical).

6. Mounting: per architect: Surface T-bar Snap in Spline Mounting panel.

7. Pattern: Fixedor Full Adjustable (Horizontal to Vertical).

8. Dampers: Radial blade.

9. Accessories:

   a. Equalizing grid.

   b. Plaster ring (where required for ceiling construction); See architectural drawings for ceiling construction).

   c. Safety chain.

   d. Sectorizing Baffles (where called for on drawings)

   e. Earthquaker Tabs (provide only if project in seismic zone)

B. Square Plaque <TITUS MODEL OMNI>

1. Manufacturers: Subject to compliance with requirements, provide produces by one of the following:

   a. Anemostat Produces; a Mestek company

   b. Carnes

   c. Krueger

   d. Metalaire, Inc.

   e. Nailor Industries Inc.

   f. Price Industries

   g. Titus

   h. Tuttle & Bailey

2. Devices shall be specifically designed for variable-air-volume flows

3. Material; Steel; 22 gauge Plaque face and Backpan; Aluminum heavy gauge with equivalent strength to steel for plaque face and backpan. Plaque panel shall have an aerodynamically shaped and rolled edge to ensure a tight to ceiling horizontal discharge pattern

4. Module Size:

   a. Steel; 12 x12 inches with a 9 x 9 inch plaque (minimum) and 24 x 24 inch with an 18 x 18 inch (minimum) plaque.

   b. Aluminum; 24 x 24 inch with an 18 x 18 inch plaque (minimum)

5. Face Style; Flat Plaque

6. Mounting; Surface, snap-in, T bar and spline; See architectural drawings for ceiling construction

7. Dampers; Radial blade

8. Accessories

   a. Equalizing Grid

   b. Sectorizing Baffles (where called for on drawings)

   c. Earthquaker Tabs (provide only if project in seismic zone)

   d. Insulated backpan

9. Finish; Standard Baked acrylic paint (white); (See drawings for scheduled finish or other special finish as scheduled on drawings.

2.3 LINEAR SLOT OUTLETS

A. Linear Bar Diffuser <TITUS MODELS CT-480, CT-580, & CT-540>:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Anemostat Products; a Mestek company.

   b. Carnes.

   c. Krueger.

   d. METALAIRE, Inc.

   e. Nailor Industries Inc.

   f. Price Industries.

   g. Titus.

   h. Tuttle & Bailey.

2. Devices shall be specifically designed for variable-air-volume flows.

3. Material; extruded aluminum bars and heavy gauge extruded aluminum frame/border.

   a. For floor applications, bars and frame/border shall be specifically designed for floor applications with a minimum of 200 pounds per square inch.

b. Bars for ceiling and sidewall diffusers shall be supported per manufacturers standard design but in no case shall the interval between supports exceed 9 feet maximum. Bars for floor diffusers shall be supported per manufacturers standard design but in no case shall the interval between supports exceed 6 feet maximum.

c. Bar support shall be parallel to the short dimension of diffuser.

d. Diffuser core shall be locked into frame/border.

4. Finish; Baked acrylic paint white, aluminum or clear anodized as scheduled on the drawings or other special finish as scheduled on drawings.

5. Core Spacing Arrangement; for core bar spacing, bar width and bar deflection, see Air Distribution Schedule on Drawings.

6. Frame/Border; See Air Distribution Device schedule for frame and border types.

7. Damper; adjustable opposed blade

8. Accessories;

a. Alignment strips and pins for continuous diffusers with multiple diffusers sections.

b. Blank-off strips where called for on drawings

c. For straight diffusers, provide extruded aluminum end borders to match at each end.

d. For diffusers that change direction, provide mitered joints at directional change.

e. Plaster frame; See architectural drawing for diffusers where construction requires this type frame

9. Where shown on drawing, diffuser shall be curved to radius called for on drawings. Minimum curvature radius 6 feet.

B. Linear Slot Diffuser <TITUS MODEL ML-37, ML-38, & ML-39>:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anemostat Products; a Mestek company.

b. Carnes.

c. Hart & Cooley Inc.

d. Krueger.

e. METALAIRE, Inc.

f. Nailor Industries Inc.

g. Price Industries.

h. Titus.

i. Tuttle & Bailey.

2. Devices shall be specifically designed for variable-air-volume flows.

3. Material; Face and frame/border shall be heavy gauge extruded aluminum.

4. Pattern Controller; Aerodynamically curved "Ice-tong" shaped steel deflector with 180º pattern adjustment from the face. Maximum length of pattern controller 3 feet. For linear diffusers longer than three feet, multiple section of pattern controller shall be provided.

5. See Air Distribution Device schedule for frame and border types.

6. Finish; Baked acrylic paint, white or aluminum as scheduled on the drawings or other special finish as scheduled on drawings.

   a. Pattern controller shall be baked acrylic paint, black

7. Length; See drawing for linear diffuser required length. Linear diffuser shall be made up of multiple section of 6 feet or smaller.

8. Slots; One (1) through eight (8) with ½, ¾ & 1 inch slot width as scheduled on drawings

9. Frame/Border; See Air Distribution Device schedule for frame and border types.

10. Accessories;

    a. Alignment strips and pins for continuous diffusers with multiple diffusers sections.

    b. Blank-off strips where called for on drawings. Cold rolled steel with black finish

    c. For straight diffusers, provide extruded aluminum end borders to match at each end.

    d. For diffusers that change direction, provide mitered joints at directional change.

    e. Plaster frame; See architectural drawing for diffusers where construction requires this type frame.

11. Where shown on drawing, diffuser shall be curved to radius called for on drawings. Minimum curvature radius 6 feet.

C. Ceiling/Sidewall-Integral Continuous Diffuser <TITUS MODEL FL>

1. Manufacturers: Subject to compliance with requirements, provide produces by one of the following:

   a. Anemostat Produces; a Mestek company

   b. Carnes

   c. Krueger

   d. Metalaire, Inc.

   e. Nailor Industries Inc.

   f. Price Industries

   g. Titus

   h. Tuttle & Bailey

2. Material; Face and frame/border minimum 0.062 inch extruded aluminum

3. Pattern Controller;

   a. Type 1; Aerodynamically designed to discharged air flow flat against the ceiling plane and designed to maintain air flow at the ceiling plane in a variable air volume application without dumping. Design shall also allow the air flow discharged to be adjusted in either direction.

   b. Type 2; Aerodynamically designed to "jet" the air vertically in a ceiling application and also has the ability to adjust the air flow vector either left or right. For sidewall applications, aerodynamically designed "jet" the air horizontally and also has the ability to adjust the air flow vector either up or down.

   c. Material; Extruded aluminum.

   d. Length; Maximum 24 inches

4. Frame/Border; See Air Distribution Device schedule for frame/border types

5. Finish; Baked acrylic paint, white as scheduled on the drawings or other special finish as scheduled on drawings.

   a. Pattern controller shall be baked acrylic paint, black

6. Slots; One (1) or two (2) as scheduled on drawings

7. Slot Width; 1, 1 ½, 2, 2 1/2 or 3 inch as scheduled on drawings.

8. Accessories;

a. Spline support clips for continuous diffusers with multiple diffusers sections.

b. Blank-off strips where called for on drawings. Cold rolled steel with black finish

c. For straight diffusers, provide extruded aluminum end borders to match at each end.

d. For diffusers that change direction, provide mitered joints at directional change.

e. Mitered cross where called for on drawings

f. Plaster frame; See architectural drawing for diffusers where construction requires this type frame.

g. Where this diffuser type is used for return air, provide a perforated (minimum 51% free area) galvanized sheet metal return hood/ light shield with a baked acrylic paint, black finish.

9. Where shown on drawing, diffuser shall be curved to radius called for on drawings. Minimum curvature radius 6 feet.

2.4 REGISTERS AND GRILLES

A. Adjustable Bar Register (supply, return or exhaust) <TITUS MODEL 300/350 SERIES>:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anemostat Products; a Mestek company.

b. Carnes.

c. Krueger.

d. METALAIRE, Inc.

e. Nailor Industries Inc.

f. Price Industries.

g. Titus.

h. Tuttle & Bailey.

2. Construction

a. Steel with 1 ¼ inch border on all sides, full penetration welded corners, steel double deflection blades spaced ¾ inches on center with steel friction pivots at either end of blade to permit individual adjustment of each deflection blade without loosening or rattling. Plastic pivots not acceptable.

b. Aluminum with 1 ¼ inch border on all sides, air distribution devices 24 x 24 inches or smaller shall have rolled borders with a minimum thickness of 0.032 inches; air distribution devices larger than 24 x 24 shall have continuous aluminum extrusions with a minimum thickness of 0.040 through 0.050 inches and shall be interlocked at the four corners and mechanically staked, double deflection blades spaced ¾ inches on center with friction pivots at either end of blade to permit individual adjustment of each deflection blade without loosening or rattling. Plastic pivots not acceptable.

c. Stainless steel (Type 304) with 1 3/8 inch border on all sides, full penetration welded corners, double deflection blades spaced ¾ inches on center with friction pivots at either end of blade to permit individual adjustment of each deflection blade without loosening or rattling. Plastic pivots not acceptable.

3. Finish: Baked acrylic paint, white as scheduled on the drawings or other special finish as scheduled on drawings.

4. Face Blade Arrangement: Horizontal Vertical spaced 3/4 inch (19 mm).

5. Rear-Blade Arrangement: Horizontal Vertical spaced 3/4 inch (19 mm).

6. Mounting: Countersunk screw.

7. Damper Type: Adjustable opposed blade. Damper construction material to match air distribution device construction.

B. Adjustable Bar Grille (Supply):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anemostat Products; a Mestek company.

b. Carnes.

c. Krueger.

d. METALAIRE, Inc.

e. Nailor Industries Inc.

f. Price Industries.

g. Titus.

h. Tuttle & Bailey.

2. Construction

a. Steel with 1 ¼ inch border on all sides, full penetration welded corners, steel single or double deflection blades spaced ¾ inches on center with steel friction pivots at either end of blade to permit individual adjustment of each deflection blade without loosening or rattling. Plastic pivots not acceptable.

b. Aluminum with 1 ¼ inch border on all sides, air distribution devices 24 x 24 inches or smaller shall have rolled borders with a minimum thickness of 0.032 inches; air distribution devices larger than 24 x 24 shall have continuous aluminum extrusions with a minimum thickness of 0.040 through 0.050 inches and shall be interlocked at the four corners and mechanically staked, single or double deflection blades spaced ¾ inches on center with friction pivots at either end of blade to permit individual adjustment of each deflection blade without loosening or rattling. Plastic pivots not acceptable.

c. Stainless steel (Type 304) with 1 3/8 inch border on all sides, full penetration welded corners, single or double deflection blades spaced ¾ inches on center with friction pivots at either end of blade to permit individual adjustment of each deflection blade without loosening or rattling. Plastic pivots not acceptable.

3. Finish: Baked acrylic paint, white as scheduled on the drawings or other special finish as scheduled on drawings.

4. Face Blade Arrangement: Horizontal Vertical spaced 3/4 inch (19 mm).

5. Rear-Blade Arrangement: Horizontal Vertical spaced 3/4 inch (19 mm).

6. Mounting: Countersunk screw.

C. Fixed Bar Register (Return)

1. Manufacturers: Subject to compliance with requirements, provide produces by one of the following:

a. Anemostat Produces; a Mestek company

b. Carnes

c. Krueger

d. Metalaire, Inc.

e. Nailor Industries Inc.

f. Price Industries

g. Titus

h. Tuttle & Bailey

2. Construction

a. Steel with 1 ¼ inch border on all sides, full penetration welded corners, fixed steel single deflection blades spaced ¾ inches on center. Blades shall be held in place by mullions behind grille and fixed to grille by welding

b. Aluminum with 1 ¼ inch border on all sides, air distribution devices 24 x 24 inches or smaller shall have rolled borders with a minimum thickness of 0.032 inches; air distribution devices larger than 24 x 24 shall have continuous aluminum extrusions with a minimum thickness of 0.040 through 0.050 inches and shall be interlocked at the four corners and mechanically staked, fixed single deflection blades spaced ¾ inches on center. Blades shall be held in place by mullions behind grille and fixed to grille by welding

c. Stainless steel (Type 304) with 1 3/8 inch border on all sides, full penetration welded corners, fixed single deflection blades spaced ¾ inches on center. Blades shall be held in place by mullions behind grille and fixed to grille by welding

3. Blade Deflection Angle: 0°, 35°, 45° as scheduled on drawings

4. Finish: Baked acrylic paint, white as scheduled on the drawings or other special finish as scheduled on drawings.

5. Face Blade Arrangement: Horizontal Vertical

6. Mounting; Countersunk screws

7. Damper Type: Adjustable opposed blade. Damper construction material to match air distribution device construction.

D. Fixed Bar Grilles (Return)

1. Manufacturers: Subject to compliance with requirements, provide produces by one of the following:

a. Anemostat Produces; a Mestek company

b. Carnes

c. Krueger

d. Metalaire, Inc.

e. Nailor Industries Inc.

f. Price Industries

g. Titus

h. Tuttle & Bailey

2. Construction

a. Steel with 1 ¼ inch border on all sides, full penetration welded corners, fixed steel single deflection blades spaced ¾ inches on center. Blades shall be held in place by mullions behind grille and fixed to grille by welding

b. Aluminum with 1 ¼ inch border on all sides, air distribution devices 24 x 24 inches or smaller shall have rolled borders with a minimum thickness of 0.032 inches; air distribution devices larger than 24 x 24 shall have continuous aluminum extrusions with a minimum thickness of 0.040 through 0.050 inches and shall be interlocked at the four corners and mechanically staked, fixed single deflection blades spaced ¾ inches on center. Blades shall be held in place by mullions behind grille and fixed to grille by welding

c. Stainless steel (Type 304) with 1 3/8 inch border on all sides, full penetration welded corners, fixed single deflection blades spaced ¾ inches on center. Blades shall be held in place by mullions behind grille and fixed to grille by welding

3. Blade Deflection Angle: 0° 35° 45° as scheduled on drawings

4. Finish: Baked acrylic paint, white as scheduled on the drawings or other special finish as scheduled on drawings.

5. Face Blade Arrangement: Horizontal Vertical

6. Mounting; Countersunk screws

2.5 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Cleanliness of sheet metal.

3.3 INSTALLATION

A. All air distribution equipment shall be installed in accordance with the latest industry standards, per the manufacturer's recommendations and as indicated on the Drawings.

B. General: Install air devices in accordance with manufacturer’s written instructions and in accordance with recognized industry practices to ensure that products serve intended function.

C. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air devices with other work.

D. Ceiling Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location. Changes in duct size and/or location shall be made where necessary to conform to site conditions without additional cost to the Owner.

E. All ductwork and distribution devices indicated on drawings is schematic. Therefore, changes in duct size and/or location shall be made where necessary to conform to space conditions, without additional cost to the Owner.

F. Install diffusers, register, and grilles with airtight connection to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

G. All ductwork; register boxes, air chambers, dampers, and all auxiliary work of any kind, necessary to make the various air conditioning, ventilating and heating systems of the building complete and ready for operation, shall be furnished and installed.

H. The specifications refer to SMACNA standards, which shall be considered minimal. If local codes require other standards than described in SMACNA, local codes shall govern.

I. Dimensions given on drawings of all acoustically lined ducts shall be the clear inside dimension. See Division 23; Section titled “METAL DUCTS” for acoustical lining requirements

J. Furnish and install manual dampers, registers, grilles, register boxes, access doors, sound traps, etc., as described herein and elsewhere in the specifications and as required for a complete system, ready for operation.

K. Exact dimensions of register boxes must await approval of grilles, and exact locations shall be submitted for approval, otherwise any changes directed after installation shall be made without additional cost. All register boxes and other opening of the ductwork must be kept tightly closed during construction to keep out rubbish.

L. This contractor shall be fully responsible for coordinating the electrical power feed arrangements (voltage/phase/amperage) for all devices requiring same, as indicated on the electrical contract documents. In the event that the devices delivered to the site do not comply with the electrical feed arrangements, he shall be fully responsible for all costs incurred to remediate the situation.

3.4 FACTORY TESTING

A. All air distribution equipment shall be tested in accordance with the latest applicable industry standards and as specified herein.

3.5 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

X:\Specs\210104\Permit - 5-20-22\23 37 13 Diffusers, Registers, And Grilles.doc

SECTION 23 37 23 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Goosenecks.

1.3 PERFORMANCE REQUIREMENTS

A. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

1.4 COORDINATION

A. Coordinate sizes and locations of roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.

C. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 (Z275) zinc coating, mill phosphatized.

D. Stainless-Steel Sheet: ASTM A 666, Type 304, with No. 4 finish.

E. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.

2. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.

F. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 GOOSENECKS

A. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 6-5; with a minimum of 0.052-inch- (1.3-mm-) thick, galvanized-steel sheet.

B. Roof Curbs

1. Mounted directly on roof

2. Material: Galvanized sheet metal construction with mitered and welded corners and seams.

3. Provide either straight sides and 5 inch flashing flange. 45˚cant and 5 inch flashing flange or raised 45˚ cant and 5 inch flashing flange. Coordinate type with roofing system.

4. Provide wood nailer if required by type of roofing system

5. Insulated roof curb with 1 ½ inches of ridge insulation

6. Coating: Manufacturer's standard coating

7. For roof curbs mounted directly on a sloped roof, construct roof curb to match roof slope

8. Minimum curb height 12 inches.

C. Galvanized-Steel Sheet Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.

2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.

3. Factory Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat and an overall minimum dry film thickness of 2 mils (0.05 mm).

4. For shop fabricated Goosenecks, paint inside and outside surface with two coats of Bituminous Paint as specified in sub-paragraph 2.1.G titled Materials.

D. Capacities and Characteristics:

1. Capacity: See drawings.

2. Width and Depth: See drawing.

3. Minimum of 150°F Deg from vertical.

4. Terminate gooseneck with the lowest portion of outlet a minimum of 30 inches above roof.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install goosenecks on curb base.

B. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

C. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 07 92 00 "Joint Sealants" for sealants applied during installation.

D. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in Division 23, Section titled, "Metal Ducts". Drawings indicate general arrangement of ducts and duct accessories.

END OF SECTION 23 37 23

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SECTION 23 41 00 - PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pleated panel filters. (Type 1)

2. Rigid cell box filters. (Type 2)

3. Front- and rear-access filter frames.

4. Side-service housings.

5. Filter gages.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

2. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

3. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.

1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.

2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.

3. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of filter and rack to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide two complete (pre-filters and final filters) sets of filters for each air handling unit and air conditioning unit. One set of filters to be installed by the HVAC Contractor immediately prior to the air balancing and testing required in Division 23; Section titled "Testing and Balancing". The other set of filters shall be delivered to the Owner's stock at the time of initial occupancy of project.

2. Provide one container(s) of red oil for inclined manometer filter gage.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."

2. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

C. Fire Performance Characteristics: Provide filters identical with those tested for the fire performance characteristics indicated. Identify with appropriate markings of applicable testing and inspecting agency.

D. Electrical Component Standard: Provide components that comply with NFPA 70 "National Electrical Code."

E. NEMA Compliance: Provide electrical components required as part of filter assembly that are listed and labeled by UL and comply with applicable NEMA standards.

F. Listing and Labeling: Provide electrical components that are listed and labeled.

1. The Terms "Listed and Labeled": As defined in the "National Electrical Code," Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

G. NFPA Compliance: Comply with applicable portions of NFPA 90A and 90B pertaining to installing air filters.

H. ASHRAE Compliance: Comply with provisions of ASHRAE Standard 52 for method of testing and rating air filter units.

I. AHRI Compliance: Comply with provisions of AHRI Standard 850 pertaining to testing and performance of air filter units.

J. UL Rating: Air filters shall have either a Class 1 or Class 2 rating in accordance with UL 900, standard for test performance of air filter units.

1.7 COORDINATION

A. Coordinate sizes and locations of filters and filter boxes.

PART 2 - PRODUCTS

2.1 GENERAL

A. Air Handling Unit Filter types and sizes shall be as scheduled on the drawings.

B. Coordinate filter frames (single header, double header, box, etc) to ensure compatibility filter section provided by the Air Handling Unit Manufacturer.

C. Size filter face area for the minimum number of filters. Blank-off plates with-in filter section are not permitted.

D. Filter media shall be installed in heavy gauge steel painted with corrosion resistance paint, galvanized steel or aluminum holding frames. Frames shall be complete with gaskets and spring fasteners

E. Filter media shall be fully gasketed to prevent air bypass around the filter sections or between filter modules.

F. Filters located on the suction side of the fan shall be installed on the downstream side of filter so the airflow pressure increases gasket seal. Filters located on the discharge side of the fan shall be installed on the upstream side of filter so that airflow pressure increases gasket seal.

G. Air Handling Unit Manufacturer shall provide side access slide-in type frame with hinged access doors.

H. All filter products shall be National Air Filtration Association certified for performance.

I. Provide a dial type filter gage on each filter bank.

J. At the option of the HVAC Contractor, filter housing maybe purchased directly from the filter manufacturer in lieu of the Air Handling unit manufacturer. If the filter housing cross section does not match the cross section of the air handling unit, the HVAC Contractor shall provide inlet and/or outlet insulated transition section to match cross section of air handling. HVAC Contractor shall verify that the additional length of the air handling unit required for the transition physical fits within the space allocated.

2.2 PLEATED PANEL FILTERS (TYPE 1)

A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AAF International.

b. Airguard.

c. Camfil Farr.

d. Columbus Industries, Inc.

e. CRS Industries, Inc.; CosaTron Division.

f. D-Mark.

g. Filtration Group.

h. Flanders-Precisionaire.

i. Koch Filter Corporation.

j. Purafil, Inc.

k. Research Products Corp.

l. Tri-Dim Filter Corporation.

B. Filter Unit Class: UL 900, Class 2.

C. Media: Cotton and synthetic fibers coated with nonflammable adhesive.

1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

3. Media shall be coated with an antimicrobial agent.

4. Separators shall be bonded to the media to maintain pleat configuration.

5. Welded wire grid shall be on downstream side to maintain pleat.

6. Media shall be bonded to frame to prevent air bypass.

7. Support members on upstream and downstream sides to maintain pleat spacing.

8. Expanded metal pleat support.

D. Filter-Media Frame: Moisture resistance cardboard double frame seal or bonded to media.

E. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

F. Capacities and Characteristics:

1. Face Dimensions: Combination of 12 x 24 inches, 24 x 12 inches and 24 x 24 inches.

2. Thickness or Depth: 2 inches (50 mm).

3. Maximum Face Velocity: 250 FPM (m/s).

4. Efficiency: 25 – 30 percent when tested in accordance with ASHRAE 52.1.

5. Arrestance: 95 percent when tested according to ASHRAE 52.1.

6. Initial Resistance: 0..20 inches wg.

7. Final Resistance: 0.50 inches wg.

8. MERV Rating: 8 when tested according to ASHRAE 52.2.

2.3 RIGID CELL BOX FILTERS (TYPE 2)

A. Description: Factory-fabricated, adhesive-coated disposable, packaged air filters with media perpendicular to airflow, and with holding frames.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AAF International.

b. Airguard.

c. Camfil Farr.

d. Columbus Industries, Inc.

e. CRS Industries, Inc.; CosaTron Division.

f. D-Mark.

g. Filtration Group.

h. Flanders-Precisionaire.

i. Koch Filter Corporation.

j. Purafil, Inc.

k. Research Products Corp.

l. Tri-Dim Filter Corporation.

B. Filter Unit Class: UL 900, Class 2.

C. Media: Micro-fine synthetic media laminated to a non-woven backing, bonded to an expanded metal wire grid and pleated to form the filter pack. Grid to maintain taper pleat form under rated airflow conditions.

1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

3. Media shall be coated with an antimicrobial agent.

D. Filter-Media Frames: Minimum 24 ga. corrosion-resistant steel casing with metal or separators on the upstream and downstream sides to maintain pleat configuration. Filter media sealed to frame to prevent air by-pass. Filter designed shall be box type or header type as required by filter housing.

E. Mounting Frames: Welded galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

F. Capacities and Characteristics: (Type 2)

1. Face Dimensions: Combination of 12 x 24 inches, 24 x 12 inches and 24 x 24 inches.

2. Depth: 4 inches

3. Efficiency 90 – 95 Percent

4. Maximum Face Velocity: 250 FPM

5. Arrestance: 99 percent when tested according to ASHRAE 52.1

6. Initial Resistance: 0.12 inches wg.

7. Final Resistance: 0.40 inches wg.

8. Merv Rating: 14

2.4 FRONT AND REAR-ACCESS FILTER FRAMES

A. Framing System: Galvanized-steel framing members with access for either upstream (front) or downstream (rear) filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AAF International.

b. Airguard.

c. Camfil Farr.

d. Columbus Industries, Inc.

e. CRS Industries, Inc.; CosaTron Division.

f. D-Mark.

g. Filtration Group.

h. Flanders-Precisionaire.

i. Koch Filter Corporation.

j. Purafil, Inc.

k. Research Products Corp.

B. Framing System

1. Coordinate filter frame configuration with air handling unit manufacturer prior to fabrication of filter frame.

2. Galvanized Steel orAluminum framing members of adequate gauge to support filters designed for front and rear access for filter servicing.

3. Filter frame shall be designed to accommodate a pre-filter and final filter.

4. Incorporate, a separate track with spring clips removable from front for pre-filter.

5. Framing members for filter subassemblies shall be factory sized, cut, pre-punched and marked for assembly into modules and configured for stacking of filters.

6. Subassembly shall be bolted in field based on the configuration above.

7. Provide vertical support to prevent deflection of horizontal members of the framing system. Support system shall be designed so as not to interfere with airflow or access to filters for removal.

8. Permanently gasket framing members to prevent unfiltered air from by-passing filter frame.

9. Provide a factory installed, positive-sealing system for each row of filters to ensure air seal between gasketed filter elements.

10. Provide all necessary hardware, fasteners and fittings to mount filters in filter frame.

11. Provide all hardware necessary for field assembly of filter frame 12. Provide a galvanized steel or 304 stainless steel base to support filter frame.

C. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1

2.5 SIDE-SERVICE HOUSINGS

A. Description: Factory-assembled modular design side-service 2 stage (pre-filter and final filter) filter housing designed to accommodate 2 inch prefilters and 4 inch supported rigid filters. Units shall be flanged suitable of insulation in a duct or attached to an air handling unit casing.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AAF International.

b. Airguard.

c. Camfil Farr.

d. Columbus Industries, Inc.

e. CRS Industries, Inc.; CosaTron Division.

f. D-Mark.

g. Filtration Group.

h. Flanders-Precisionaire.

i. Koch Filter Corporation.

j. Purafil, Inc.

k. Research Products Corp.

B. Construction of filter shall be suitable for a static pressure range for -10 in. w.g. (positive/negative). The leakage rate shall be less than 1.0% of air flow at 10 in. w.g. internal static pressure.

C. Housings are constructed of 16 ga. aluminized steel with upstream and downstream outwardly-turned flanges. Units wider than 4 ft. include intermediate support channels.

D. Filter tracks shall be extruded aluminum. The primary track accepts nominal 4 in. to 36 ins. thick filter headers and the pre-filter track accepts 2 in. or 4 in. thick panel filters. Both tracks are gasketed with replaceable polypropylene pile air seals.

E. Housings are equipped with two access doors that are sealed with neoprene gasketing on the perimeter. Gasketing shall seal the filter edge to the door.

F. Doors are equipped with 1-1/2 in. positive-sealing knobs made of UV-resistant plastic with corrosion-resistant brass inserts.

G. Sealing: Incorporate positive-sealing gasket material on channels to seal cartridge frames and to prevent bypass of unfiltered air.

H. Filter Housing design shall provide for interchanging of header type filters and different ASHRAE efficiencies as required.

I. Flanges shall be provided to accommodate in-line installation with air handling units and ductwork configuration.

J. Where more than one filter housing is required to meet the air capacity requirements, the housings shall be provided with comer posts pre-punched and gasketed for butting units together, and/or standing flanges for stacking the units on top of one another.

K. Where filter housing are installed outdoors, weatherproof units for outside installations consist of a pitched roof, rain guards over the doors and caulking of all seams.

L. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1

2.6 FILTER GAGES

A. Diaphragm-type gage with dial and pointer in metal case, vent valves, black figures on white background, and front recalibration adjustment.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Airguard.

b. Dwyer Instruments, Inc.

2. Diameter: 4-1/2 inches (115 mm).

3. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5-Inch wg (125 Pa) or Less: 0- to 0.5-inch wg (0 to 125 Pa).

4. Scale Range for Filter Media Having a Recommended Final Resistance of 0.5- to 1.0-Inch wg (125 to 250 Pa) or Less: 0- to 1.0-inch wg (0 to 250 Pa).

B. Manometer-Type Filter Gage: Molded plastic, with epoxy-coated aluminum scale and logarithmic-curve tube gage with integral leveling gage, graduated to read from 0- to 3.0-inch wg (0 to 750 Pa), and accurate within 3 percent of the full scale range.

C. Accessories: Static-pressure tips, tubing, gage connections, and mounting bracket.

D. Provide filter gage static pressure tips upstream and downstream of each filter type in the filter bank to indicate filter pressure of each filter type.

E. Provide filter gage for each filter type in the filter bank.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install filter frames and filter housing level and plumb following manufacturer's written instructions, rough-in drawings and reference standards.

B. Install air filters and holding devices of types indicated on drawings following filter manufacturer's written instructions and with recognized industry practices to ensure that filters comply and perform with requirements and serve intended purpose.

C. Locate each filter accurately in position indicated in relation to other work

D. Position each filter unit with clearance for normal service and maintenance. Anchor filter holding frames to substrate.

E. Install filters in position to prevent passage of unfiltered air.

F. Install filter gage for each filter bank.

G. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

H. Install filter-gage, static-pressure taps upstream and downstream from filters. Install filter gages on filter banks with separate static-pressure taps upstream and downstream from filters. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust and level inclined gages.

I. Coordinate filter installations with duct and air-handling-unit installations.

J. For each air handling unit and air conditioning unit that is to be used during the construction phase, provide two complete sets of 2 inch thick minimum MERV 7 replaceable media (Type 1) filters. One set shall be installed when the systems are initially started for use during the construction phase. The second set shall be installed at the direction of the Owner.

K. Fan fan coil units that are operated during the construction period, HVAC Contractor shall install a temporary air filter with frames on each return air opening. Temporary air filters shall be 1 inch thick glass fiber. Temporary air filters shall be removed at the start of air balancing. After air balancing is completed, temporary filters shall be replaced. Temporary air filters shall be removed at the time of initial occupancy of the project after the HVAC Contractor notifies the Owner. If the temporary air filter are not maintained during the construction phase up to the time of initial occupancy and the fan powered variable air volume terminal boxes and fan coil units internal surface become contaminated with dust or other foreign material, the HVAC Contractor shall clean the terminal boxes and fan coil units at no additional cost to the Owner.

3.2 FIELD QUALITY CONTROL

A. HVAC Contractor Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Test for leakage of unfiltered air while system is operating.

2. Leak-test housing by pressurizing to a minimum 3 inches wg. (750 Pa) or designed operating pressure. Soap-bubble test housing, joints, door seals and filter sealing edges.

C. Air filter will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.3 CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 23 41 00

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SECTION 23 72 10 – PACKAGED ENERGY RECOVERY UNIT (100% OUTSIDE AIR)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Packaged Energy Recovery Units (100% Outside Air).

1.3 PERFORMANCE REQUIREMENTS

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. LEED Submittals:

1. Product Data for Credit EA 4: Documentation indicating that equipment and refrigerants comply.
2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Shop Drawings: For Energy Recovery Units. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Performance requirements for overall system and each system component.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
5. Calculate requirements for selecting vibration isolators and where required for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Structural members to which equipment will be attached.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Packaged Energy Recovery Unit to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of each type of filter specified.
2. Fan Belts: One set of belts for each belt-driven fan in Energy Recovery Units.
3. Wheel Belts: One set of belts for each heat wheel.

1.8 REFERENCE STANDARDS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AHRI Compliance:

1. Capacity ratings for Packaged Energy Recovery Unit shall comply with AHRI 1060, "Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment."
2. Capacity ratings for air coils shall comply with AHRI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils."

C. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

D. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.

E. UL Compliance:

1. Packaged energy recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."
2. Electric coils shall comply with requirements in UL 1995, "Heating and Cooling Equipment."

AFBMA 9:	Load Ratings and Fatigue Life for Ball Bearings
AMCA 210:	Laboratory Methods of Testing Fans for Rating Purposes
AMCA 300:	Test Code for Sound Rating Air Moving Devices
AMCA 500:	Test Methods for Louvers, Dampers and Shutters
AHRI 410:	Forced Circulation, Air Cooling and Air Heating Coils
NEMA MG-1:	National Electrical Manufacturers Association Motor Standard
NFPA 90A:	Standard for the Installation of Air Conditioning and Ventilating Systems
SMACNA:	Sheet Metal and Air Conditioning Contractors National Association
UL 900:	Test Performance for Air Filter Units

1.9 QUALITY ASSURANCE

A. Unit manufacturer shall have a minimum of 10 years' experience in the energy recovery market.

B. The system shall deliver the specified air volume at the static pressure scheduled.

C. The unit shall be constructed to provide smooth interior surfaces and to limit the casing leakage at less than 1% of the specified air volume at operating static.

D. Unit shall be constructed in accordance with CSA C22.2 and UL 1812 and shall carry the ETL label of approval.

E. Unit shall be constructed in accordance with industrial design practices.

F. Insulation shall comply with NFPA 90A requirements for flame spread and smoke generation.

G. Airflow data shall comply with AMCA 210 method of testing.

H. Cabinet and exterior components shall be tested and certified weatherproof.

I. All units shall be 100% factory tested.

J. All effectiveness data of heat and energy recovery components shall be certified by the AHRI 1060 certification program directory.

1.10 COORDINATION

A. Coordinate layout and installation of Packaged Energy Recovery Unit and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.11 WARRANTY

A. Special Warranty: manufacturer's standard form in which manufacturer agrees to repair or replace components packaged heat recovery units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Packaged Energy Recovery Units: two years from owner's acceptance.

PART 2 - PRODUCTS

2.1 PACKAGED ENERGY RECOVERY UNIT - GENERAL

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following
1. Daikin
2. Haakon
3. Aaon
4. Venmar CES Inc.
5. Semco Incorporated

B. Unit components

1. Unit Double-Walled Casing

2. Supply Fan
3. Exhaust Fan
4. Direct Expansion Cooling Coil
5. Heat Recovery Wheel Total (sensible plus latent) Heat
6. Refrigeration System
7. Filters
8. Heating Coil (Located downstream of cooling coil)
9. Standalone Factory packaged Control System to maintain unit leaving air temperature.
10. Interface with Building Management System (BMS)

C. Unit shall be factory assembled and tested including leak testing of the coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the controls compartment's literature pocket.

D. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.

E. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.

F. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.

G. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.

2.2 CASING

A. The Energy Recovery Unit shall be suitable for installation either outdoor or indoor as indicated on the drawings. If unit is for an outdoor installation, unit shall be specifically designed for outdoor use. Indoor units weatherized for outdoor use are not acceptable.

B. All panel joints must be caulked with a weatherproof silicone. After application, the silicone must react with atmospheric moisture to produce a formed-in-pace silicone rubber glazing and curtain wall seal.

C. Unit shall be designed to reduce air leakage and infiltration through the cabinet.

1. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360.
2. Panel deflection shall not exceed L/240 ratio at of design static pressure of maximum 8 inches of positive or negative.
3. Deflection shall be measured at the midpoint of the panel height and width.

4. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Refrigerant piping, water piping, electrical conduit, etc. penetrating cabinet panels shall be sealed to reduce air leakage.
5. The unit base frame shall be constructed from a bolted or welded, structural formed G90 galvanized steel with internal structural cross members properly sized to allow rigging and handling of the unit.

    a. The deflection of the base frame shall be less than 1/360 the length of the unit when rigging.
    b. All major components shall be supported by the base without sagging or pulsating.
    c. Lifting lugs shall be provided and strategically located per section to allow equilibrium during lifting.
    d. For outdoor units scheduled to be set on roof curbs, the unit base frame shall be self flashing when set on roof curb.

6. Unit floor shall be double wall construction and be insulated with 4" fiberglass insulation (R16).

    a. Floor shall be constructed of 16 gauge G90 galvanized steel welded.
    b. Bottom face of insulation shall be protected with a 22 gauge G90 galvanized steel.
    c. Floor shall be designed to accommodate roof curb, raised structural frame or concrete pad installation.
    d. Single wall floor construction and non-insulated floor shall not be acceptable.
    e. Floor openings (supply, exhaust, return) shall be provided with upturn flanges at least ½ in height around opening.

7. Wall and roof construction shall be double-walled insulated construction.

    a. Solid G90 18 gauge galvanized steel.
    b. Interior skin solid G90 22 gauge galvanized steel
    c. Double-walled construction shall be 2 inch thick and insulated with 3.0 pounds be cubic foot with a minimum assembled insulation "R" value of 13.0 Btu/Hr/Sq. Ft./°F.
    d. Unit construction (manufacturer's standard frame) shall be adequate to meet or exceed the criteria outlined above.
    e. Outdoor units shall have a pitched roof (3% minimum) to dissipate water accumulation. Rain gutters shall be provided above access doors. All roof joint seams shall be "T" shape construction, minimum height of 1.5", sealed and encapsulated by a metal strip.

f. Outdoor air intake and exhaust air opening shall be provided with hoods constructed of G90 galvanized sheet with openings protected with a bird screen. Outdoor air intake shall be adequately sized to eliminate entrainment of water in the air stream.
g. Internal partitions shall be double-walled insulation construction as outlined above for exterior skin.

8. Access doors
   a. Full size access door(s) shall be provided to allow for periodic maintenance and inspections for all serviceable components. For heat recovery section, provide access doors upstream and downstream to facilitate coil cleaning.
   b. Doors shall be double wall construction made of 18 gauge galvanized steel on both outer and inner liner for maximum rigidity.
   c. Door insulation shall be the same as the unit panels.
   d. Provide doors with heavy duty corrosion resistant aluminum hinges that allow the door to open at 180°.
   e. Cam type handles operable from both sides of the unit access door(s) and neoprene resilient bubble gaskets for an enclosure that is sealed tight shall be provided.
   f. Door openings shall be flush with all surrounding panels.
   g. Plastic latches and continuous hinges are not acceptable.
   h. Hold open device on all access doors shall be provided.

2.3 CONDENSATE DRAIN PAN

A. Provide a condensate drain pan under cooling coils and other unit components where moisture may occur.

B. Condensate drain pan shall comply with ASHRAE 62.1.

C. Double-wall insulated drain pan shall be constructed of 16 gauge type 304 stainless steel (wet side), insulated with a minimum 1 inch high density insulation adhered to the stainless steel and covered with 20 gauge galvanized metal.

D. Drain pan shall be sloped to a 1 ½ inch stainless steel pipe drain connection at the low point of drain pan. Slope of main drain pan within unit to allow pan to drain completely dry on unit shut down.

E. For units with multiple (stacked) coils, provide stainless steel trough for each coil above bottom coil and individually piping each trough to condensate drain pan.

F. Drain pan shall extend a minimum 2 inch upstream of entering side of coil and extend downstream of leaving side of coil a distance to comply with ASHRAE 62.1 or a minimum of 12 inches.

2.4 FANS

A. Supply and exhaust fans shall be either double width double inlet (DWDI) or "un-housed" plenum centrifugal fans.

B. Fan wheel for DWDI centrifugal fans shall be non-overloading; shall be either airfoil or back-incline type. Fan wheel for "un-housed plenum centrifugal fans shall be airfoil type.

C. For fan requirements, see Division 23; Section titled "Centrifugal HVAC Fans."

D. For Motor Requirements, see Division 23; Section titled "Centrifugal HVAC Fans" and Division 23; titled "Common Motor Requirements for HVAC Equipment."

E. For Vibration Isolation and where required seismic restraint devices requirements, see vibration section in Division 23.

2.5 DIRECT EXPANSION COOLING COIL

A. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized (304 stainless) steel end casings. Fin design shall be sine wave rippled.

B. Coils shall have interlaced circuitry and shall be standard capacity.

C. Coils shall be helium leak tested.

D. Coils shall be provided with a factory installed thermostatic expansion valves.

2.6 ELECTRIC HEATING COILS

A. The electric heater casing is constructed of galvanized steel. Heater terminal box access door shall be mounted on the unit. Element construction as follows:

1. The electric heater casing is constructed of galvanized steel. Heater terminal box access door shall be mounted on the unit. Element construction as follows:

a. Open-wire type, 80% nickel, 20% chromium resistance coils, insulated by Steatite bushings and supported a galvanized steel frame. Bushings shall be recessed into embossed openings and stacked into supporting brackets, spaced no more than 4-in. centers. Maximum element heating density shall be 55 watts/sq. inch. Where electric heater manufacturer requires, element heating density shall be less than 55 watts/sq. inch as recommended.
b. Sheathed type, 80% nickel, 20% chromium resistance coils, suspended in a magnesium oxide insulator fill within a tubular steel sheath/brazed fin assembly. Silicone rubber end seals shall prevent contamination of the interior, and the exterior shall be protected from corrosion by a high temperature aluminum coating.
c. Provide protective screen on both sides of coil.
d. Pressure plate at inlet of heater to evenly distribute air across coil.

2. Each coil shall be constructed and installed in accordance with the requirements of local Authorities having jurisdiction and shall be UL approved and listed for zero clearance.

3. Each coil shall meet all of the requirements of the latest edition of the National Electric Code.

4. Each Coil shall be given a 2,000 Volt dielectric test.

5. Each electric heating coil shall be provided with an insulated terminal box and cover of suitable size to contain all of the power, controls and appurtenances required for the coil.

6. Terminal bolts, nuts and washers shall be of corrosion resistance material.

7. Each heater shall be provided with, but not limited to, the following.

a. Built-in snap-action door interlock disconnect switch.
b. Automatic and manual thermal cut-outs serviceable through the terminal box.
c. Differential air pressure or airflow switch to de-energize heater if no air flow.
d. Disconnecting, safety, controlling and back-up contractor as required for heating element type and control option. Contractors shall be of mercury type.
e. Branch circuit fusing for each 48 amp circuit per National Electric Code.
f. Separate 120 or 124 volt fused control power transformer with primary and secondary protection.
g. Terminal blocks shall be provided for all field wiring (power and control) and shall be sized for installation of 75°C copper wire, rated in accordance with NEC requirements.

h. Heaters shall be rated for the voltage, phase, and number of heating stages indicated in the schedule. All three-phase heaters shall have equal, balanced, three-phase stages. All internal wiring shall be stranded copper with 105°C insulation and shall be terminated in crimped connectors or box lugs.

8. Heater shall be suitable for control as follows:

a. Three phase heaters with total ampere draw of less than 96 amps shall be provided with SCR (proportional control).
b. Three Phase heaters with total ampere draw greater than 96 amps shall be arranged for a Vernier Proportion Control (SCR and step control).

9. Heaters shall be provided with all appurtenances as required to meet requirements of the National Electric Code or any other Codes having jurisdiction.

10. Electric heaters shall be UL listed for zero clearance and shall meet all applicable National Electric Code requirements.

11. Units with electric heat sections shall be listed under UL 1995 Standard for Safety.

2.7 FILTERS

A. Filters shall be provided in the outside air system and the exhaust air stream up-stream of the recovery equipment.

1. Outside air

a. 2 inch disposable; MERV 8
b. 4 inch ridge; MERV 14

2. Exhaust air

a. 2 inch disposable; MERV 8

B. For filter requirements, see Division 23; Section ‘Particulate Air Filtration.”

C. Provide differential pressure gauges as required.

2.8 DAMPERS

A. Air leakage through a 48” x 48” damper shall not exceed 10.3 cfm/sq/ft/ against 4 in. wg. Differential static pressure at standard air. Standard air leakage date to be certified under AMCA certified rating program.

B. Dampers are designed for operation in temperatures ranging between minus (-)40°C) and 212°F (100°C).

C. Unit shall be equipped with all necessary dampers. Dampers for outside air intake, exhaust air and all other dampers required for the system, including the dampers for defrost (if required).

D. Dampers shall be opposed blade type for modulating applications and parallel blade type for two positions. For other dampers, see manufacturer's recommendations.

E. Outside air dampers shall be motorized. Provide damper actuators with 24 VAC drive voltage or 0-10 VDC modulation available when needed.

F. Exhaust air dampers shall be motorized. Provide damper actuators with 24 VAC drive voltage or 0-10 modulation available when needed.

G. Dampers construction shall be as follows:

1. Damper frame shall be extruded aluminum.
2. Blades shall be extruded aluminum.
3. Dampers shall be opposed blade type or parallel blades where indicated.
4. Damper blade ends shall be sealed with neoprene flexible edge seals complete with bottom and top blade wiper seals.
5. Frames and blades shall be non-insulated.

2.9 HEAT RECOVERY WHEEL

A. Heat wheel shall be designed to transfer total energy (sensible plus latent heat) from the exhaust air stream to the outside air stream.

B. The rotor (wheel) housing shall be a structural framework which limits the deflection of the rotor due to air pressure loss to less than 1/32". The housing is made of galvanized steel to prevent corrosion. The rotor shall be supported by two pillow block bearings which can be maintained or replaced without the removal of the rotor from its casing or the media from its spoke system. Bearing shall be either grease lubricated with grease fitting extended to casing exterior or permanently lubricated type.

C. The rotor shall be provided in segmented fashion to allow for field erection or replacement of one media section at a time. The media shall be rigidly held in place by a structural spoke system made of extruded aluminum.

D. The rotor shall be supplied with labyrinth seals, which at no time shall make contact with any rotating surface of the exchanger rotor face. The multi-pass seals shall utilize four labyrinth stages for optimum performance. Seals shall also be provided on divider partition and purge section.

E. Rotor Media

1. The rotor media shall be made of aluminum and coated to prohibit corrosion.
2. All media surfaces shall be coated with a non-migrating solid adsorbent layer prior to being formed into the honeycomb or corrugated media structure to ensure that all surfaces are coated and that adequate latent capacity is provided.
3. The media shall have a flame spread of less than 25 and a smoke developed of less than 50 when rated in accordance with ASTM E84.
4. The faces of the total energy recovery wheel shall be sealed with an acid resistant coating to limit surface oxidation anti-stick additive to limit the collection of dust or smoke particulate and to aid in the surface cleaning process should cleaning be required.
5. The entire recovery wheel media face shall be treated with an antimicrobial agent. The antimicrobial agent shall carry EPA registration for use in duct systems.
6. The media shall be coated with an inorganic desiccant specifically developed for the selective adsorption of water vapor. The desiccant shall utilize a molecular sieve certified by the manufacturer to have an internal pore diameter distribution which limits adsorption to materials not larger than the critical diameter of a water molecule (2.8 angstroms.)
7. Dry particles up to [600] [800] [1200] microns shall pass freely through the media.
8. The following certifications tested by a qualified independent shall be submitted:

    a. Effectiveness of the anti-stick to limit the collection dust and smoke particulate and to aid in the surface cleaning process.
    b. Effectiveness of the antimicrobial agent.
    c. Desiccant surfaces exhibit bacteria-static properties.
    d. The cross-contamination and performance certification reports documenting that the desiccant material utilized does not transfer pollutants typically encountered in the indoor air environment.
    e. Documentation of the heat wheel's sensible and latent recovery efficiencies when conducted in accordance with ASHRAE 84-78P and the results presented in accordance with AHRI 1060 standards.

F. Purge Sector

1. The unit shall be provided with a factory set, field adjustable purge sector designed to limited cross contamination to less than .04 percent of that of the exhaust air stream concentration when operated under appropriate conditions.

G. Media Cleaning

1. The media shall be cleanable with low-pressure steam (less than 5 PSI), hot water or light detergent, without degrading the latent recovery.

H. Rotor Drive

1. Variable speed control shall be accomplished by the use of a VFD

2. The VFD shall include all digital programming.

3. The drive system shall allow for a turndown ratio of 80:1 (20 rpm to 1/4 rpm).

2.10 REFRIGERANT SYSTEM

A. Unit shall be factory charged with R-410A refrigerant.

B. Refrigerant system shall be complete with compressors, direct expansion (DX) cooling coils, refrigerant piping, expansion valves, and refrigerant appurtenances required for a fully operational system. For applications that utilize an air cooled condenser, refrigerant piping shall be extended to the exterior of the unit and capped for field piping to air cooled condenser.

C. Compressors shall be scroll type with thermal overload protection, independently circuited, and carry a 5 year non-prorated warranty.

D. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam insulated panels to prevent the transmission of noise outside the cabinet.

E. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area. Manufacturer shall submit certification that the vibration isolation will not transmit sound or noise into the building structure.

F. Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.

G. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and factory installed liquid line filter driers.

H. Unit shall include [1] [2] [4] stages of capacity control.

I. Unit shall include a variable capacity scroll compressor on the all refrigeration circuit(s) which shall be capable of modulation from 10-100% of its capacity.

J. Lead refrigeration circuit(s) shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.

K. Each refrigeration circuit shall be equipped with a liquid line sight glass.

L. Each refrigeration circuit shall be equipped with suction and discharge compressor isolation valves.

M. Each capacity stage shall be equipped with a 5 minute off, delay timer to prevent compressor short cycling.

N. Each capacity stage shall be equipped with an adjustable, 20 second delay timer to prevent multiple capacity stages from starting all at once.

O. Lead (All) (Lag) refrigeration circuit(s) shall be provided with factory installed hot gas bypass to protect against evaporator frosting and to prevent excessive compressor cycling.

P. Lead refrigeration circuit shall be provided with hot gas reheat coil, on/off control valves and a control signal terminal which allow the unit to have a dehumidification mode of operation.

Q. Each refrigeration circuit shall include adjustable compressor lockouts.

R. For applications with an air cooled condenser, the first capacity stage shall be provided with on/off condenser fan cycling and adjustable compressor lockout to allow cooling operation down to 35°F.

S. Each refrigeration circuit shall be provided with an adjustable temperature sensor freeze stat which shuts down the cooling circuits when the evaporator coil tubing falls below the set point.

2.11 ROOF CURBS

A. Roof curb shall be supplied by the unit manufacturer for field assembly.

B. See vibration section in Division 23 for roof curb requirements in addition to the requirements listed below.

C. Curb shall be capable of supporting and constructed of galvanized steel sections, double wall with 2” thick fiberglass insulation. Stiffeners shall be provided for field assembly as required.

D. Curbs shall 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.

E. Curb shall be adjustable up to 3/4 inch per foot to allow for sloped roof applications.

F. Curb shall be a custom per design drawing details.

2.12 LIGHTS AND GFI RECEPTACLE

A. Vapor tight lights (marine) shall be located throughout unit for proper maintenances of all components in the unit.

B. Lights shall be wired to a single switch on the unit exterior mounted in a weatherproof junction box.

C. A GFI receptacle shall be provided mounted in a weatherproof junction box next to the light switch.

2.13 One electrical point of connection for the 480v operation of the unit, with a separate convenience outlet powered through the unit with its own disconnect and fusing. ELECTRICAL

A. All electrical controls shall be ETL listed and the entire unit shall be factory wired in accordance with the National Electric Code Standard.

B. Provide a NEMA type enclosure to house all electrical components for a fully operation unit. Enclosures shall be as follows:
   1. Outdoor Enclosures; NEMA 250; Type 4

C. Units shall be supplied with a non-fused main power disconnect switch. A single point power connection shall be provided for all units.

D. The following is a partial list of high voltage components necessary for an operational unit. Manufacturer shall provide all additional components for a fully operational unit.

   1. Motor starters on all high voltage motors for constant speed applications. See Division 23; Section titled “Enclosed Controllers” for motor starter requirements
   2. Thermal protection on all high voltage motors.
   3. Fuses and fuse holders.
   4. All necessary control transformers.
   5. Supply and exhaust/return fans shall be provided with ECM control. Unit is a constant volume system and variable frequency drives shall be used for balancing only.

E. Unit shall be completed with all necessary relays, time delay, damper actuators with auxiliary switches (as required).

F. Unit shall be start and stopped from a signal from a Building management System (BMS).

G. Terminal board shall be provided for low voltage control wiring. Low voltage is 24V.

H. An integral control panel for factory mounted controls and interface with the Building management shall be provided having a hinged access door and an approved locking device.

I. All control devices, except those not mounted directly to the unit, shall be factory mounted and wired. Control panel shall have a labeled strip to land all wires for field installed control components.

J. All components are fully wired and 100% tested prior to shipping.

K. Marine type lights complete with one switch per access door wired to: junction box, disconnect, or transformer.

L. Fan access doors are equipped with a momentary interrupt switch that shuts off the unit when a protected door is opened. These switches can be removed if belt guards are installed on the fan assembly.

2.14 CONTROLS

A. Unit shall be provided with a factory mounted Direct Digital Control (DDC). Control system shall include the capability of interfacing with the Building Management System (BMS) as outlined below.

B. Control Sequence:

1. When unit receives signal to start, outside air damper shall open and exhaust air damper shall open. When both dampers fully opened as determined by an end switch, supply and exhaust fan shall start. When unit receives a signal to stop, supply fans and exhaust fans shall stop and after a 30 second delay (adjustable), outside air and exhaust air dampers shall close.

2. Application with direct expansion cooling coil and refrigerant system:

a. When the outside air temperature is above 55°F (adjustable):

(i) A temperature sensor located downstream of the direct expansion cooling coil shall modulate in sequence the heat recovery wheel and refrigeration system to maintain 55°F (adjustable) cooling coil leaving air temperature.

(ii) A temperature sensor located downstream of the hot gas refrigerant heating coil and the electric heating coil control valve shall modulate in sequence to maintain 68°F (adjustable) until leaving air temperature.

(iii) When refrigeration cycle is activated, control valve on condenser water supply shall open and when refrigeration cycle is de-activated, the control valve shall stop.

(iv) When refrigeration cycle is activated, air cooled condenser shall be activated and control sequence to control condensing of refrigerant.

b. When the outside air temperature is below 50°F (adjustable):

(i) Refrigerant cycle shall be de-activated and temperature sensor located downstream of cooling coil shall be reset to 68°F (adjustable) and shall modulate heat recovery wheel to maintain its setting.

(ii) Temperature sensor located downstream of electric coil shall modulate to maintain 68°F (adjustable) unit leaving air temperature.

C. Frost prevention temperature sensor shall be provided to prevent frost from occurring on the heat wheel through the use of the Wheel VFD.

D. Wheel effectiveness control will be provided by the Wheel VFD which will modulate its speed to meet the discharge air temperature (DAT) set point using factory mounted temperature sensors. The energy wheel is the first form of heating or cooling when active. Compressors or heat will only be active when the energy recovery wheel cannot satisfy the discharge air temperature.

E. Smoke detector (provided as part of the work of Division 26) located in the discharge air duct shall stop unit in the event smoke is detected.

F. Unit manufacturer shall include, as part of the unit, hot gas control valve, temperature sensors, damper operators and all appurtenances necessary for a full operational control system.

G. Unit manufacturer shall also include provisions to allow for the items listed in following subparagraph to interface with the Building management System (BMS). The interface shall be set up for 0-10V or 4-20 ma signals.

H. The following shall be controlled or monitored by the Building management System.

1. Unit start/stop
2. Cooling coil discharge air temperature

3. Heating coil discharge air temperature
4. Exhaust air dirty filter alarm
5. Outside air dirty pre-filter alarm
6. Outside air dirty secondary filter
7. Heat wheel-failure to rotate
8. Common unit trouble alarm

2.15 UNIT PIPING

A. Units using a refrigeration system with a remote air cooled condenser refrigerant piping shall be extended to the exterior of the unit and capped by unit manufacturer.

2.16 CAPACITY AND CHARACTERISTICS

A. See drawing for Package Heat Recovery Unit schedule.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for all services (piping, electrical, controls, etc.) to verify actual locations of connections before installation.

D. Examine locations for indoor units on concrete equipment pads, roof preparation for roof curbs and structural frame for outdoor units mounted above roof for size, anchors locations, vibration provisions, etc.

E. Examine roof and or wall openings to verify size and locations of opening.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Outdoor Unit set on roof curb

1. Install curb on roof structure or concrete base, level and secure, according to the NRCA "Roofing and Waterproofing Manual – Volume 4: Construction Details – Low-Slope Roofing," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts."

2. Install unit curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07; Section titled "Thermal and Moisture Protection."

3. See vibration section in Division 23 and provide vibration isolation and where required seismic restraint devices.

4. Secure unit to upper curb rail, and secure unit to upper curb rail and secure curb base to roof structure or concrete base with anchor bolts.

5. Coordinate roof penetrations.

B. Outdoor units set on a structural frame.

1. Structural support frame shall be provided as part of the work of another contractor. HVAC contractor shall furnish setting diagrams, unit support points, unit weight at each supports point, templates, etc. to contractor responsible for structural frame.

2. Install unit of structural frame and shim unit to level unit.

3. See vibration section in Division 23 and provide vibration isolation between unit and structural frame and where required seismic restraint devices.

4. Secure unit to structural frame.

5. Coordinate roof penetrations.

C. Install wind (outdoor units only) restraint as required to meet requirements in vibration section of Division 23 and manufacturer's recommendations.

D. Pipe drains from drain pans to nearest floor drain; use ASTM B 88, Type L, drawn-temper copper water tubing with soldered joints, same size as condensate drain connection.

E. Install new filters at completion of equipment installation just prior to the start of testing, adjusting and balancing.

3.3 CONNECTIONS

A. Install piping adjacent to unit to allow service and maintenance.

B. Connect cooling condensate drain pans with air seal trap at connection to drain pan and install cleanouts at changes in pipe direction.

C. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." For applications with Air Cooled Condenser, coordinate with Air Cooled Condenser manufacturer and size refrigerant piping based on final pipe routing and extend piping between unit and air cooled condenser.

D. Comply with requirements for ductwork specified in Division 23; Section titled "Metal Ducts" and Section titled "Air Duct Accessories."

E. Coordinate final connections of the Building management System to the unit.

F. Coordinate Contractor of Division 26 final electric power to unit.

3.4 FIELD QUALITY REPORTS

A. Perform inspection, test and adjust.

1. HVAC contractor shall engage a factory-authorized service representative assist in testing and adjusting of unit.

B. Tests and Inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Adjust seals and purge.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

4. Set initial temperature and humidity set points.

5. Set field-adjustable switches and circuit-breaker trip ranges as required for proper operation of unit.

6. Verify date transmission to Building Management System (BMS).

7. Record temperature as follows:

a. Outside air (upstream of heat recovery equipment)
b. Outside air (downstream of heat recovery equipment)
c. Exhaust air (upstream of heat recovery equipment)
d. Exhaust air (downstream of heat recovery equipment)

C. Packaged energy recovery equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain packaged heat recovery units. Include 8 hours of on-site and 8 hours of classroom training.

END OF SECTION 23 72 10

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SECTION 23 81 29 – VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes complete VRF HVAC system(s) including, but not limited to the following components to make a complete operating system(s) according to requirements indicated:
1. Indoor Units – Ducted (Ceiling-mounted)
2. Indoor Units – Ductless (Wall-mounted, ceiling-mounted cassette, ceiling suspended)
3. Outdoor, air-source, condensing units – 3 phase power (heat pump and/or heat recovery).
4. Heat recovery control units.
5. System controls.
6. System refrigerant and oil.
7. System control cable and raceways.

1.3 DEFINITIONS

A. Air-Conditioning System Operation: System capable of operation with all zones in cooling only.

B. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.

C. Heat Recovery System Operation: System capable of operation with simultaneous heating and cooling zones that transfer heat between zones.

D. HRCU: Heat Recovery Control Unit. HRCUs are used in heat recovery VRF HVAC systems to reverse the flow of refrigerant between the HRCU and the Fan Coil. "Heat Recovery Control Unit" is the term used by ASHRAE for what different manufacturers term as branch circuit controller, branch selector box, heat recovery unit, changeover box, flow selector unit, mode change unit, and other such terms.

E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

F. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

G. VRF: Variable refrigerant flow.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units and for HRCUs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include operating performance at design conditions.
4. Include minimum allowable ambient temperatures for simultaneous heating and cooling operation.
5. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
6. Include description of control software features.
7. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.
8. Include refrigerant type and data sheets showing compliance with requirements indicated.
9. Indicate location and dimensional requirements for service access.

B. Shop Drawings: For VRF HVAC systems.

1. Include plans, elevations, sections, and mounting or attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings. Piping diagrams shall include refrigerant charge calculation based on the refrigerant line lengths shown in the shop drawings. If VRF system submittals are provided prior to piping shop drawings submittals, VRF system calculations must be resubmitted for review again after piping shop drawings have been approved.
5. Include diagrams for power, signal, and control wiring.

C. Additional Design Submittals requirements:
1. Contractor to confirm with the manufacturer, the refrigerant pipe sizing for each system based an approved pipe routing submittal.
2. Include design calculations with corresponding floor plans indicating that refrigerant concentration limits are within allowable limits of ASHRAE 15 and governing codes.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural floors, roofs and associated members to which equipment, piping, ductwork, cables, and conduit will be attached.
3. Size and location of initial access modules for acoustical tile.
4. Wall-mounted controllers located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
5. Size and location of access doors and panels installed behind walls and inaccessible ceilings for products installed behind walls and requiring access.
6. Items penetrating finished ceiling including the following:

    a. Luminaires.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Service access panels.

B. Qualification Data:

1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.

    a. Training shall be conducted at jobsite with installing crew by factory-certified trainer.

    b. Retain copies of Installer certificates on-site and make available on request.

2. For VRF HVAC system manufacturer: Equipment must be listed on AHRI's website directory.

C. Product Certificates: For each type of product.

1. AHRI Certificate of Product Ratings

D. Product Test Reports: Where tests are required, for each product, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.

E. Sample Warranties: For manufacturer's warranties.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On CD or DVD, USB media, or approved cloud storage platform, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: Refer to Specification Section 23 41 00 Particulate Air Filtration for Maintenance Material Requirements.

2. Indoor Units: One for each unique size and type installed.
3. Controllers for Indoor Units: One for each unique controller type installed.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Nationally recognized manufacturer of VRF HVAC systems and products.
2. Has shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
3. VRF HVAC systems and products that have been successfully tested and in use on at least twenty completed projects of similar size.
4. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
5. Has received third-party testing under AHRI Standard 1230 guidelines.
6. Having full-time in-house employees for the following:

a. Product research and development.
b. Product and application engineering.
c. Product manufacturing, testing, and quality control.
d. Technical support for system installation training, startup, commissioning, and troubleshooting of installations.
e. Owner training.

B. Factory-Authorized Service Representative Qualifications:

1. Authorized representative of, and trained by, VRF HVAC system manufacturer.
2. In-place facility located within 20 miles of Project.
3. Demonstrated experience on ten projects of similar complexity, scope, and value.

    a. Each person assigned to Project shall have demonstrated experience.

4. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
5. Service and maintenance staff assigned to support Project during warranty period.
6. Local product parts inventory to support ongoing system operation for a period of not less than ten years after Substantial Completion.

C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.

1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
2. Installer certification shall be valid and current for duration of Project.
3. Retain copies of Installer certificates on-site and make available on request.
4. Each person assigned to Project shall have demonstrated past experience.

    a. Demonstrated past experience with products being installed for period within three consecutive years before time of bid.
    b. Demonstrated past experience on three projects of similar complexity, scope, and value.

5. Installers shall have staffing resources of competent, trained, and experienced full-time employees that are assigned to execute work according to schedule.

D. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

E. Units shall be tested by a National Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
3. Do not run units for space heating or cooling or drying out of space or for any other reason during the construction phase of the project while significant dusts are being generated.

E. Replace installed products damaged during construction.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Faulty operation.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period:

a. For Compressor: 10 years from date of Substantial Completion.
b. For Parts, Including Controls: 10 years from date of Substantial Completion.
c. For Labor: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. One of the following:
1. Daikin
2. LG North America
3. Mitsubishi
4. Samsung
5. Hitachi

B. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:

1. Indoor and outdoor units, including accessories.
2. Controls and software.
3. HRCUs.

4. Refrigerant isolation valves.
5. Specialty refrigerant pipe fittings.

2.2 SYSTEM DESCRIPTION

A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, HRCUs, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.

1. Maximum system refrigerant volume as specified on the drawings.
2. System(s) operation, air-conditioning heat pump or heat recovery as indicated on Drawings.
3. Each system with one refrigerant circuit shared by all indoor units connected to system.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory**.**

D. ASHRAE Compliance:

1. ASHRAE 15: For safety code for mechanical refrigeration.

2. ASHRAE 34: For safety classification of refrigerants
3. ASHRAE 62.1: For indoor air quality.
4. ASHRAE 135: For control network protocol with remote communication.
5. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.

E. UL Compliance: Comply with UL 1995.

2.3 PERFORMANCE REQUIREMENTS

A. Service Access:

1. Provide and document service access requirements.
2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
4. If less than full and unrestricted access is provided, locate components within an 18-inch (450-mm) reach of the finished assembly.
5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.

6. Comply with OSHA regulations.

B. System Design and Installation Requirements:

1. Design and install systems indicated according to manufacturer's recommendations and written instructions.
2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.

C. Isolation of Equipment: Provide isolation valves to isolate each HRCU**,** indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.

D. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor-unit rated capacity:

1. Not less than 50 percent.
2. Not more than 200 percent.

E. System Turndown: Stable operation down to 20 percent of outdoor-unit capacity.

F. Outdoor Conditions:

1. Suitable for outdoor ambient conditions encountered.
   a. Provide corrosion-resistant coating for components and supports where located in coastal or industrial climates that are known to be harmful to materials and finishes.

2. Maximum System Operating Outdoor Temperature: See Drawings.
3. Minimum System Operating Outdoor Temperature: See Drawings.

G. Sound Performance: Sound levels generated by operating HVAC equipment shall be within requirements indicated.

1. Indoor: Within design guidelines of "2015 ASHRAE HANDBOOK- HVAC Applications."
2. Outdoor: Within ordinance of governing authorities

H. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes.

I. Capacities and Characteristics: As indicated on Drawings.

J. Ability to reset subcooling/superheat target.

K. Ability to reset refrigerant target.

2.4 INDOOR UNITS – DUCTED (CEILING-MOUNTED)

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

B. Cabinet:

1. Material: Galvanized steel.
2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
3. Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
4. Mounting: Manufacturer-designed provisions for field installation.
5. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Galvanized steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Unit Internal Tubing: Copper tubing with brazed joints.
6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
3. Condensate Overflow Protection: Provide high-level condensate safety shutoff and alarm.
4. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:

1. Fan(s):

a. Direct-drive arrangement.
b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
c. Fabricated from non-ferrous components or ferrous components with corrosion-resistant finish.

d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
2. Minimum Efficiency (Ceiling-Mounted Units): ASHRAE 52.2, MERV 14, unless otherwise noted on drawings.
3. Provide accessory filter kit and/or filter box if necessary, to provide the required MERV 14 rating.
4. Media:

a. Replaceable (Ceiling-Mounted Units): Extended surface, panel, or cartridge with antimicrobial treatment fiber media.

G. Unit Accessories:
1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

H. Unit Controls:

1. Enclosure: Metal, suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:

a. Unit inlet air temperature.
b. Coil entering refrigerant temperature.
c. Coil leaving refrigerant temperature.

4. Field-Customizable I/O Capability:
a. Digital Inputs: One.

5. Features and Functions:

a. Self-diagnostics.
b. Time delay.
c. Auto-restart.
d. External static pressure control.
e. Auto operation mode.
f. Manual operation mode.
g. Filter service notification.

h. Power consumption display.
i. Drain assembly high water level safety shutdown and notification.
j. Run test switch.

6. Communication: Network communication with other indoor and outdoor units.
7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

I. Unit Electrical:

1. Enclosure: Metal, suitable for indoor locations.
2. Field Connection: Single point connection to power unit and integral controls.
3. Disconnecting Means: Field-installed circuit breaker or switch.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

2.5 INDOOR UNITS – DUCTLESS (WALL-MOUNTED, CEILING-MOUNTED CASSETTE)

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

B. Cabinet:

1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
3. Mounting: Manufacturer-designed provisions for field installation.
4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Unit Internal Tubing: Copper tubing with brazed joints.
6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.

9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal:
   a. Unit-mounted pump or other integral lifting mechanism for ceiling units, capable of lifting drain water to an elevation above top of cabinet.
   b. Condensate Overflow Protection: Provide high-level condensate safety shutoff and alarm.

3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:

1. Fan(s):

   a. Direct-drive arrangement.
   b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
   c. Materials: Non-ferrous components or ferrous components with corrosion-resistant finish.
   d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access:
   a. Bottom for ceiling-mounted units.
   b. Provide access to accommodate filter replacement without the need for tools.
2. Media:
   a. Washable for ceiling-suspended units. Manufacturer's standard filter with antimicrobial treatment.

   b. Replaceable for ceiling-mounted units.
      1) Extended surface, panel, or cartridge with antimicrobial treatment fiber media.
      2) Minimum Efficiency: ASHRAE 52.2, MERV 14, unless otherwise noted on drawings.
      3) Provide accessory filter kit and/or filter box if necessary, to provide the required MERV 14 rating.

G. Discharge-Air Grille Assembly: Manufacturer's standard discharge grille with field-adjustable air pattern mounted in unit cabinet.

1. For Ceiling-Mounted Units:
   a. Discharge Pattern: One-, two-, three-, or four-way throw as indicated on Drawings.
   b. Discharge Pattern Adjustment: Field-adjustable limits for up and down range of motion.
   c. Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns.
   d. Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.
   e. Additional Branch Supply Duct Connection: Sheet metal knockout for optional connection to one additional supply branch duct.

H. Return-Air Grille Assembly for Ceiling-Mounted Units: Manufacturer's standard grille mounted in bottom of unit cabinet.

I. Unit Accessories:

1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

J. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:
   a. Unit inlet air temperature.
   b. Coil entering refrigerant temperature.
   c. Coil leaving refrigerant temperature.
4. Field-Customizable I/O Capability:
   a. Digital Inputs: One.
5. Features and Functions:
   a. Self-diagnostics.
   b. Time delay.
   c. Auto-restart.
   d. External static pressure control.
   e. Auto operation mode.
   f. Manual operation mode.
   g. Filter service notification
   h. Power consumption display.
   i. Drain assembly high water level safety shutdown and notification.

j. Run test switch.

6. Communication: Network communication with other indoor units and outdoor unit(s).
7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

K. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Field-installed circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

2.6 OUTDOOR, AIR-SOURCE CONDENSING UNITS – 3 PHASE POWER (HEAT PUMP AND/OR HEAT RECOVERY)

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Provide heat pump units as designated on Drawings.

2. Heat Pump Units are specially designed for use in systems with either all heating or all cooling demands, but not for use in systems with simultaneous heating and cooling.

3. Heat Recovery Units are specially designed for use in systems with simultaneous heating and cooling.
4. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
5. All units installed shall be from the same product development generation.

B. Cabinet:

1. Galvanized steel and coated with a corrosion-resistant finish.

a. Coating with documented salt spray test performance of 1000 hours according to ASTM B 117 surface scratch test (SST) procedure.

2. Mounting: Manufacturer-designed provisions for field installation.
3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Compressor and Motor Assembly:

1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive, vapor injection and turndown to 15 percent of rated capacity.
2. Protection: Integral protection against the following:

    a. High refrigerant pressure.
    b. Low oil level.
    c. High oil temperature.
    d. Thermal and overload.
    e. Voltage fluctuations.
    f. Phase failure and phase reversal.
    g. Short cycling.

3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
4. Vibration Control: Integral isolation to dampen vibration transmission.
5. Oil management system to ensure safe and proper lubrication over entire operating range.
6. Crankcase heaters with integral control to maintain safe operating temperature.
7. Fusible plug.

D. Condenser Coil Assembly:

1. Plate Fin Coils:

    a. Casing: Aluminum, galvanized, or stainless steel.
    b. Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
    c. Tubes: Copper, of diameter and thickness required by performance.

    d. Hydrophylic coating with documented salt spray test performance of 1000 hours according to ASTM B 117 surface scratch test (SST) procedure.

2. Corrosion Protection: Coating with documented salt spray test performance of 1000 hours according ASTM B 117 surface scratch test (SST) procedure.
3. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

E. Condenser Fan and Motor Assembly:

1. Fan(s): Propeller type.

    a. Direct-drive arrangement.
    b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
    c. Statically and dynamically balanced.

2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
5. Speed Settings and Control: Variable speed with a speed range of least 75 percent.
6. Vibration Control: Integral isolation to dampen vibration transmission.

F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection. Provide a dedicated hot gas refrigerant circuit at bottom of condenser coil used to cool inverter so that no auxiliary drain pan heater is required. If there is no a dedicated inverter cooling circuit, condensing unit will require aux drain pan heater.

G. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:

    a. Refrigerant suction temperature.
    b. Refrigerant discharge temperature.
    c. Outdoor air temperature.
    d. Refrigerant high pressure.
    e. Refrigerant low pressure.
    f. Oil level.

4. Features and Functions:
    a. Self-diagnostics,
    b. time delay,
    c. auto-restart,
    d. fuse protection,
    e. auto operation mode,
    f. manual operation mode,
    g. night setback control,
    h. run test switch
    i. equalize run time between multiple same components
5. Communication: Network communication with indoor units and other outdoor unit(s).
6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

H. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.

3. Disconnecting Means: Field-installed circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

I. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevention corrosion when exposed to salt spray test for 1000 hours according ASTM B 117.

J. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.7 HEAT RECOVERY CONTROL UNITS (HRCUs or BSBs)

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple unit that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.

B. Cabinet:

1. Galvanized-steel construction.
2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
3. Mounting: Manufacturer-designed provisions for field installation.
4. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

D. Refrigeration Assemblies and Specialties:

1. Specially designed by manufacturer for type of VRF HVAC system being installed, either two or three pipe.
2. Each refrigerant branch circuit shall have refrigerant control valve(s) to control refrigerant flow.

3. Spares: Each heat recovery control unit shall include at least one branch circuit port(s) for future use.
4. Each system piping connection upstream of heat recovery unit shall be fitted with an isolation valve to allow for service to any heat recovery control unit in the system without interrupting operation of the system.
5. Each branch circuit connection shall be fitted with an isolation valve and capped service port to allow for service to any individual branch circuit without interrupting operation of the system.

    a. If not available as an integral part of the heat recovery control unit, isolation valves shall be field installed adjacent to the unit pipe connection.

E. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:
4. Features and Functions:
    a. Self-diagnostics,
    b. fuse protection,
5. Communication: Network communication with indoor units and outdoor unit(s).
6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

F. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

G. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.8 SYSTEM CONTROLS

A. General Requirements:

1. Network: Indoor units**,** HRCUs, and outdoor units shall include integral controls and connect through a manufacturer-selected control network.
2. Network Communication Protocol: Manufacturer-proprietary control communication between interconnected units.
3. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL), including the following:

    a. Ethernet connection via RJ-45 connectors and port with transmission at 100 Mbps or higher.
    b. Integration devices shall be connected to local uninterruptible power supply unit(s) to provide at least 5 minutes of battery backup operation after a power loss.
    c. Integration shall include control, monitoring, and scheduling.

4. Operator Interface:

    a. Operators shall interface with system and unit controls through the following:

        1) Operator interfaces integral to controllers.
        2) Owner-furnished PC connected to central controller(s).
        3) Web interface through web browser software.
        4) Integration with Building Automation System.

    b. Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:

        1) On/off control.
        2) Temperature set-point adjustment.

B. Central Controllers:

1. Centralized control for all indoor and outdoor units from a single central controller location.

    a. Include multiple interconnected controllers as required.

2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.

    a. Sets schedule for daily, weekly, and annual events.

b. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.

4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
5. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
7. Service diagnostics tool.
8. Able to disable and enable operation of individual controllers for indoor units.
9. Information displayed on individual controllers shall also be available for display through central controller.
10. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.
11. Operator interface through a backlit, high-resolution color display touch panel.

C. Wired Controllers for Indoor Units:

1. Single controller capable of controlling multiple indoor units as group.
2. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
3. Multiple Language: English
4. Temperature Units: Fahrenheit
5. On/Off: Turns indoor unit on or off.
6. Hold: Hold operation settings until hold is released.
7. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
8. Temperature Display: 1-degree increments.
9. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments between
10. Fan Speed Setting: Select between available options furnished with the unit.
11. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.
12. Seven-day programmable operating schedule with up to eight events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
13. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
14. Occupancy detection.
15. Service Notification Display: "Filter"
16. Service Run Tests: Limit use by service personnel to troubleshoot operation.
17. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
18. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
19. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.
20. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.

D. Wireless Controllers for Indoor Units (if required):

1. Wireless Communication:

   a. Third-Party controller communicates to remote-mounted receiver that is wired to indoor unit(s).

      1) Include receivers with wireless controllers as required to complete installation.
      2) Low-voltage power required for receivers shall be powered through non-polar connections to indoor unit.

   b. One wireless controller shall be capable of communicating with one or multiple receivers to control one or multiple indoor units as a group.

2. Controller Battery Life: Three years.
3. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
4. Language: English
5. Temperature Units: Fahrenheit.
6. On/Off: Turns indoor unit on or off.
7. Hold: Hold operation settings until hold is released.
8. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
9. Temperature Display: 1-degree increments.
10. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments
11. Relative Humidity Display: 1 percent increments.
12. Relative Humidity Set-Point: Adjustable in 1 percent increments
13. Fan Speed Setting: Select between available options furnished with the unit.
14. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.
15. Seven-day programmable operating schedule with up to eight events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
16. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
17. Occupancy detection.
18. Service Notification Display: "Filter"
19. Service Run Tests: Limit use by service personnel to troubleshoot operation.
20. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
21. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
22. Setting stored in non-volatile memory to ensure that settings are not lost if power is lost. Battery for date and time only.

2.9 SYSTEM REFRIGERANT AND OIL

A. Refrigerant:

1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.
2. ASHRAE 34, Class A1 refrigerant classification.
3. R-410a

B. Oil:

1. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

2.10 SYSTEM CONDENSATE DRAIN PIPING

A. Comply with requirements in Section 23 21 13 "Hydronic Piping" for system piping requirements.

2.11 SYSTEM REFRIGERANT PIPING

A. Comply with requirements in Section 23 23 00 "Refrigerant Piping" for system piping requirements.

B. Divided-Flow Specialty Fittings: Where required by VRF HVAC system manufacturer for proper system operation, VRF HVAC system manufacturer shall furnish specialty fittings with identification and instructions for proper installation by Installer.

C. Refrigerant Isolation Ball Valves:

1. Description: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap.
2. Seals: Compatible with system refrigerant and oil. Seal service life of at least 20 years.
3. Valve Connections: Flare or sweat depending on size.

2.12 PIPING AND TUBING INSULATION

A. Comply with requirements in Section 23 07 19 "HVAC Piping Insulation" for system piping insulation requirements.

2.13 SYSTEM CONTROL CABLE

A. Cable Rating: Listed and labeled for application according to NFPA 70.

1. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

    a. Flame Travel Distance: 60 inches (1520 mm) or less.
    b. Peak Optical Smoke Density: 0.5 or less.
    c. Average Optical Smoke Density: 0.15 or less.

2. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
3. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

B. Low-Voltage Control Cabling:

1. Paired Cable: NFPA 70, Type CMG.

    a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
    b. PVC insulation.
    c. Braided or foil shielded.
    d. PVC jacket.
    e. Flame Resistance: Comply with UL 1685.
2. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

    a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.
    b. PVC insulation.
    c. Braided or foil shielded.
    d. PVC jacket.
    e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.
    f. Flame Resistance: Comply with NFPA 262.

C. TIA-485A Network Cabling:

1. Standard Cable: NFPA 70, Type CMG.

    a. Paired, one pair twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
    b. PVC insulation.
    c. Unshielded.
    d. PVC jacket.
    e. Flame Resistance: Comply with UL 1685.
2. Plenum-Rated Cable: NFPA 70, Type CMP.

    a. Paired, one pair No. 22 AWG, stranded (7x30) tinned-copper conductors.
    b. Fluorinated ethylene propylene insulation.

c. Unshielded.
d. Fluorinated ethylene propylene jacket.
e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.
f. Flame Resistance: NFPA 262.

D. Ethernet Network Cabling: TIA-568-C.2 Category 6 cable with RJ-45 connectors.

1. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of category cable indicated.
2. Conductors: 100-ohm, 23 AWG solid copper.
3. Shielding: Unshielded twisted pairs (UTP) or Shielded twisted pairs (FTP).
4. Cable Rating: By application.
5. Jacket: White, Gray, Blue, or Yellow thermoplastic.

E. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems" for control wiring and cable raceways.

2.14 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect factory-assembled equipment.

B. Equipment will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports for historical record. Submit reports only if requested.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.

D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.

E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.

F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.

G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

H. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION, GENERAL

A. Clearance:

1. Maintain manufacturer's recommended clearances for service and maintenance.
2. Maintain clearances required by governing code.

B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.

3.3 INSTALLATION OF INDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch (10 mm).

C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.

D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.

E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.

F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.

G. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25 inch (13 mm).

H. For wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.

3.4 INSTALLATION OF OUTDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Install outdoor units on support structures indicated on Drawings.

C. Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete" or Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."

1. Attachment: Install anchor bolts to elevations required for proper attachment to supported equipment.
2. Grouting: Place grout under equipment supports and make bearing surface smooth.

D. Roof-Mounted Installations: Install outdoor units on equipment supports specified in Section 07 72 00 "Roof Accessories." Anchor units to supports with removable, stainless-steel fasteners.

3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping and tubing to permit valve servicing.

F. Install piping and tubing at indicated slopes.

G. Install piping and tubing free of sags.

H. Install fittings for changes in direction and branch connections.

I. Install piping and tubing to allow application of insulation.

J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.

K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 23 05 17 "Sleeves and Sleeve Seals for HVAC Piping."

3.6 INSTALLATION OF SYSTEM CONDENSATE DRAIN PIPING

A. General Requirements for Drain Piping and Tubing:

1. Install a union in piping at each threaded unit connection.
2. Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:

    a. Details indicated on Drawings.
    b. Manufacturer's requirements.
    c. Governing codes.
    d. In the absence of requirements, comply with requirements of ASHRAE handbooks.

4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.
5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.

B. Gravity Drains:

1. Slope piping from unit connection toward drain termination at a constant slope of not less than one percent.

C. Pumped Drains:

1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.7 INSTALLATION OF HYDRONIC PIPING

A. Comply with requirements for hydronic pipe and tubing specified in Section 23 21 13 "Hydronic Piping."

B. Comply with requirements for hydronic specialties specified in Section 23 21 16 "Hydronic Piping Specialties."

C. Install continuous-thread hanger rods and hangers of size required to support equipment weight.
1. Comply with requirements for hangers and supports specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

D. Where installing piping and tubing adjacent to equipment, allow space for service and maintenance.

3.8 INSTALLATION OF REFRIGERANT PIPING

A. Refrigerant Tubing Kits:

1. Unroll and straighten tubing to suit installation. Deviations in straightness of exposed tubing shall be unnoticeable to observer.
2. Support tubing using hangers and supports indicated at intervals not to exceed 5 feet (1.5 m). Minimum rod size, 1/4 inch (6.4 mm).
3. Prepare tubing ends and make mating connections to provide a pressure tight and leak-free installation.

B. Install refrigerant piping according to ASHRAE 15 and governing codes.

C. Select system components with pressure rating equal to or greater than system operating pressure.

D. Install piping as short and direct as possible, with a minimum number of joints and fittings.

E. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 08 31 13 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

F. Install refrigerant piping and tubing in protective conduit where installed belowground.

G. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.

H. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:

1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps to entrain oil in vertical runs.
4. Liquid lines may be installed level.

I. When brazing, remove or protect components that could be damaged by heat.

J. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.

K. Joint Construction:

1. Ream ends of tubes and remove burrs.
2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.
3. Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

a. Use Type BCuP (copper-phosphorus) alloy for joining copper fittings with copper tubing.
b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

3.9 GROUNDING INSTALLATION

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.10 IDENTIFICATION

A. Identify system equipment, piping, tubing, and valves. Comply with requirements for identification specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."

B. Identify system electrical and controls components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

1. Identify each control cable on each end and at each terminal with a number-coded identification tag. Each cable shall have a unique tag.

3.11 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.

1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.

a. Additional factory-authorized representatives may assist with completion of certain activities only if supervised by manufacturer's employee. A factory-authorized representative shall not provide assistance without manufacturer's employee supervision.

2. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.

a. First Visit: Kick-off meeting.
b. Second Visit: At approximately 25 percent completion of system(s).
c. Third Visit: At approximately 50 percent completion of system(s).
d. Fourth Visit: At approximately 75 percent completion of system(s).

e. Fifth Visit: Final inspection before system startup.

3. Kick-off Meeting:

   a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.
   b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.
   c. Meeting shall cover the following as a minimum requirement:

      1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.
      2) Manufacturer's installation requirements specific to systems being installed.
      3) Review of all relevant VRF HVAC system submittals, including delegated-design submittals.
      4) Required field activities related installation of VRF HVAC system.
      5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.

4. Site Visits: Activities for each site visit shall include the following:

   a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.
   b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.
   c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.
   d. Advise and if necessary assist Installer with updating related refrigerant calculations and system documentation.
   e. Issue a report for each visit, documenting the visit.

      1) Report to include name and contact information of individual making the visit.
      2) Date(s) and time frames while on-site.
      3) Names and contact information of people meeting with while on-site.
      4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.

5. Final Inspection before Startup:

   a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according manufacturer's requirements and ready for final inspection.
   b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.
   c. Manufacturer shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.
   d. Inspection reports for indoor units shall include, but not be limited to, the following:

      1) Unit designation on Drawings.
      2) Manufacturer model number.
      3) Serial number.
      4) Network address, if applicable.
      5) Each equipment setting.
      6) Mounting, supports, and restraints properly installed.
      7) Proper service clearance provided.
      8) Wiring and power connections correct.
      9) Line-voltage reading(s) within acceptable range.
      10) Wiring and controls connections correct.
      11) Low-voltage reading(s) within an acceptable range.
      12) Controller type and model controlling unit.
      13) Controller location.
      14) Temperature settings and readings within an acceptable range.
      15) Humidity settings and readings within an acceptable range.
      16) Condensate removal acceptable.
      17) Fan settings and readings within an acceptable range.
      18) Unit airflow direction within an acceptable range.
      19) If applicable, fan external static pressure setting.
      20) Filter type and condition acceptable.
      21) Noise level within an acceptable range.
      22) Refrigerant piping properly connected and insulated.
      23) Condensate drain piping properly connected and insulated.
      24) If applicable, ductwork properly connected.
      25) If applicable, external interlocks properly connected.
      26) Remarks.

   e. Inspection reports for outdoor units shall include, but not be limited to, the following:

      1) Unit designation on Drawings.
      2) Manufacturer model number.
      3) Serial number.
      4) Network address, if applicable.

5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Condensate removal acceptable.
13) Noise level within an acceptable range.
14) Refrigerant piping properly connected and insulated.
15) Condensate drain piping properly connected and insulated.
16) Remarks.

f. Installer shall provide manufacturer with the requested documentation and technical support during inspection.
g. Installer shall correct observed deficiencies found by the inspection.
h. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.
i. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.
j. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than 1.5 times VRF HVAC system operating pressure, but not less than 600 psig (4137 kPa), using dry nitrogen.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.

4. Prepare test report to record the following information for each test:

    a. Name of person starting test, company name, phone number, and e-mail address.
    b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
    c. Detailed description of extent of tubing tested.
    d. Date and time at start of test.
    e. Test pressure at start of test.
    f. Outdoor temperature at start of test.
    g. Name of person ending test, company name, phone number, and e-mail address.
    h. Date and time at end of test.
    i. Test pressure at end of test.
    j. Outdoor temperature at end of test.
    k. Remarks:

5. Submit test reports for Project record.

D. Refrigerant Tubing Evacuation Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500 microns.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of one hour(s) with no change.
4. Prepare test report to record the following information for each test:

    a. Name of person starting test, company name, phone number, and e-mail address.
    b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
    c. Detailed description of extent of tubing tested.
    d. Date and time at start of test.
    e. Test pressure at start of test.
    f. Outdoor temperature at start of test.
    g. Name of person ending test, company name, phone number, and e-mail address.
    h. Date and time at end of test.
    i. Test pressure at end of test.
    j. Outdoor temperature at end of test.
    k. Remarks:

5. Submit test reports for Project record.
6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.

E. System Refrigerant Charge:

1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.
2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
3. System refrigerant charging shall be witnessed by system manufacturer's representative.
4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

F. Products will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.12 STARTUP SERVICE

A. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.

1. Service representative shall be a factory-trained and -authorized service representative of VRF HVAC system manufacturer.
2. Complete startup service of each separate system.
3. Complete system startup service according to manufacturer's written instructions.

B. Startup checks shall include, but not be limited to, the following:

1. Check control communications of equipment and each operating component in system(s).
2. Check each indoor unit's response to demand for cooling and heating.
3. Check each indoor unit's response to changes in airflow settings.
4. Check each indoor unit**,** HRCU**,** and outdoor unit for proper condensate removal.
5. Check sound levels of each indoor and outdoor units.

C. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.

1. Installer shall correct deficiencies found during startup service for reverification.

D. System Operation Report:

1. After completion of startup service, manufacturer shall issue a report for each separate system.
2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
3. Manufacturer shall electronically record not less than two hours of continuous operation of each system and submit with report for historical reference.

a. All available system operating parameters shall be included in the information submitted.

E. Witness:

1. Invite Commissioning Agent to witness startup service procedures.
2. Provide written notice not less than 20 business days before start of startup service.

3.13 ADJUSTING

A. Adjust equipment and components to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.

C. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.

D. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.14 PROTECTION

A. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.

B. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.

C. Protect equipment from electrical damage. Replace equipment suffering electrical damage.

D. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

3.15 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include three service visits for preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment and system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.16 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.17 DEMONSTRATION

A. Engage a VRF HVAC system manufacturer's factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.

B. Instructor:

1. Instructor shall be factory trained and certified by VRF HVAC system manufacturer with current training on the system(s), equipment, and controls that are installed.
2. Instructor's credentials shall be submitted for review by Commissioning Agent before scheduling training.
3. Instructor(s) primary job responsibility shall be Owner training.
4. Instructor(s) shall have not less than three years of training experience with VRF HVAC system manufacturer and past training experience on at least three projects of comparable size and complexity.

C. Schedule and Duration:

1. Schedule training with Owner at least 20 business days before first training session.
2. Training shall occur before Owner occupancy.
3. Training shall be held at mutually agreed date and time during normal business hours.
4. Each training day shall not exceed eight hours of training. Daily training schedule shall allow time for one-hour lunch period and 15-minute break after every two hours of training.
5. Perform not less than 16 total hours of training.

D. Location: Owner shall provide a suitable on-site location to host classroom training.

E. Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee's name, signature, phone number, and e-mail address.

F. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training. Include 8 hours of on-site and 8 hours of classroom training.

G. Training Materials: Provide training materials in electronic format to each attendee.

1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.

H. Acceptance: Obtain Commissioning Agent and Owner written acceptance that training is complete and requirements indicated have been satisfied.

END OF SECTION 23 81 29

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SECTION 23 82 39.19 - WALL AND CEILING HEATERS (ELECTRIC)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include details of anchorages and attachments to structure and to supported equipment.

4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.

5. Wiring Diagrams: Power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide product of manufacturer scheduled on drawings or one of the following:

1. Qmark

2. Indeeco

3. Trane
4. Markel Products
5. Chromalox
6. Berko

B. General

1. Incremental wall or ceiling mounted with factory-finished enclosure fans, motors, coils and grille.
2. Heating Medium; Resistance electric
3. Mounting configuration; Wall (surface), Wall (recessed), Ceiling (surface) and Ceiling (recessed).
4. Unit shall be UL listed

C. Enclosure

1. Heavy duty steel with removable front panels fastened with tamperproof fasteners
2. Stamped-steel grille or extruded aluminum bar grille (18 gauge) as scheduled on drawings
3. Design for surface mounting or recessed mounting as schedule on drawings
4. Factory finished with a baked enamel paint over manufacturer's standard prime coating. Finished color selected by Architect from manufacturer's standard colors.
5. Surface mounting box (color to match front panel)
6. Recessed trim kit for recessed units as required

D. Coils

1. Capacity as scheduled on drawings
2. Coil design; Resistance type nichrome elements with open wire design or industrial grade finned sheathed tubular elements per manufacturers standard design concept
3. Heating elements shall terminate in a terminal box
4. Heating element design shall be free from expansion, noise and 60Hz hum
5. Electrical Input; See schedule on drawings for heater voltage and phase requirements.
6. Single point of electrical connection for both heating elements and fan

7. Disconnect/contactor

8. Automatic thermal reset cut-out

9. Transformer Voltage as required for unit size (fused on secondary and grounded

10. Fan interlocked with heating coil to prevent coil from being activated with fan running.

11. Heater shall be complete with electrical components, devices, accessories, etc required for full compliance with the latest edition of the National Electric Code and State and Local authorities having jurisdiction.

E. Fan

1. Propeller type arranged for draw-thru air flow design to provide uniform air movement over entire heating element surface.

2. Aluminum blades mounted on hub

3. Fan wheel directly mounted to motor shaft

F. Motor

1. Manufacturers standard design permanently lubricated and thermally protected

2. See Division 23; Section titled "Common Motor Requirements for HVAC Equipment" for additional requirements

G. Electrical Components, Devices, Accessories; Listed and labeled as defined in latest edition of NFPA 70 by a qualified testing agency and marked for intended location and application.

H. Controls; Factory wired unit mounted (with plug for tamperproof installation) or wall mounted thermostat as scheduled on drawings. Heater manufacturer to provide wall mounted thermostat (line or low voltage as required for heater wiring.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive wall and ceiling heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. For recessed units, coordinate wall and/or ceiling opening required for heater with Contractor responsible wall or ceiling construction.

3.2 INSTALLATION

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install wall and ceiling unit heaters level and plumb.

C. For heaters with wall thermostat, install heater in wall electrical box at a height required to meet American with Disabilities Act, Fair Housing Act or other Federal, State and Local codes having jurisdiction. Wiring between thermostat and heater shall be in metallic conduit

D. Wiring to comply with applicable Sections of Division 26

END OF SECTION 23 82 39.19

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SECTION 23 83 23.16 - RADIANT-HEATING ELECTRIC MATS

NVENT NUHEAT MAT FLOOR HEATING SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section includes UL Listed and CSA Certified floor heating systems.

1.2 REFERENCES

A. Reference Standards
   1. UL515 – Electrical Resistance Heat Tracing for Commercial Applications
   2. IEEE 515.1-2012 Standard for the Testing, Design, Installation & Maintenance of Electric Resistance Trace Heating for Commercial Applications.
   3. CSA Standard C22.2 No. 130-03 Requirements for Electrical Resistance Heating Cables & Heating Device Sets
   4. NFPA 70 - National Electrical Code
   5. CSA Standard C22.1 – Canadian Electrical Code
   6. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI—current edition)
   7. UL 1693, Second Edition
   8. UL 1683, Issue No. 2
   9. NEC Article 424 Floor Warming Systems
   10. AMERICAN SOCIETY for TESTING & MATERIALS (ASTM—current edition)

1.3 SYSTEM DESCRIPTION

A. System Description: Electric radiant floor heating system consisting of a resistance heating wire bonded in a pre-configured pattern between two porous layers of fabric and thermostat(s) with built-in Class A GFCI protection.
   1. The pre-formed electric floor heating product is manufactured to fit the shape of the heated floor area, without the need for on-site alterations or configuration, to ensure evenly distributed warmth throughout the heated floor area.
   2. Heating product thickness shall not exceed 1/8 inch (3.2 mm).
   3. The heating products must be protected by a minimum, non-pro-rated, 25-year warranty.
   4. This system must be approved for use under ceramic tile, marble, other natural stone, laminate, engineered wood, and luxury vinyl floor coverings.
   5. Thermostat must have built-in class A GFCI protection, floor sensing and ambient air sensing capabilities.

6. Thermostat must work with Amazon Alexa, Google Assistant, Google Nest, IFTTT, Control4, and/or other custom integrations using thermostat manufacturer's Open API.

1.4 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. Product Data
   1. Floor heating data sheet
   2. UL Listed certificates for floor heating
   3. System installation and operation instructions
   4. System installation details
   5. Thermostat data sheet
   6. Thermostat wiring diagram

B. Shop Drawings
   1. Detailed engineered drawings showing layout(s) of the floor.

1.5 QUALITY ASSURANCE

A. Source Limitations
   1. All system components (heating products, thermostats, and any other accessories) shall be sourced from a single manufacturer and under no circumstances shall components be installed other than those supplied by the system manufacturer to ensure system integrity and meet warranty requirements.

B. Qualifications
   1. Manufacturers
      a. Manufacturer must have a minimum of thirty (30) years of experience in manufacturing floor heating systems.
      b. Manufacturer must be ISO-9001 registered.
      c. Manufacturer must provide floor heating product that meets IEEE 515.1, CSA 22.2 No 130-03, and UL1683 requirements.
   2. Installers
      a. System installer shall have a complete understanding of all relevant products and product literature directly from the manufacturer or from an authorized representative of the manufacturer prior to installation. Electrical connections shall be performed by a licensed electrician or otherwise appropriately qualified electrical contractor.
   3. Labelling of Electrical Components, Devices, and Accessories
      a. All system components (heating products, thermostats, and any other accessories) must be listed and labelled as defined in NFPA 70, Article 100, by a Nationally Recognized Testing Laboratory (NRTL), and marked for intended use.

C. Certifications

a. All system components (heating products, thermostats, and any other accessories) shall be UL Listed and CSA Certified for floor heating.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery And Acceptance Requirements

1. All system components must be delivered, stored, and handled in such a way as to prevent their deterioration or damage due to moisture, temperature changes, contaminates, or other causes.
2. All system components must be delivered to the site in original unopened containers or packages with intact and legible manufacturer's labels and must include the following information:
   a. Product and Manufacturer
   b. Size and Quantity
   c. Lot Number
   d. Installation and Operation Instructions
   e. MSDS (if applicable)

B. Storage And Handling Requirements

1. All system components must be stored in a clean, dry location with a temperature range not below -40°F (-40°C) and not exceeding 140°F (60°C).
2. All system components must be protected from mechanical damage.

1.7 WARRANTY

A. Manufacturer Warranty

1. The manufacturer must warranty all heating products and membranes with a comprehensive, non-prorated written twenty-five (25) year warranty against product defects which covers replacement materials and applies when installed under ceramic tile, marble, other natural stone, laminate, engineered wood, and luxury vinyl floor coverings.
2. The manufacturer must warranty all thermostats with a comprehensive, non-prorated written three (3) year warranty against product defects which covers replacement materials.

B. Installer Warranty

1. This special warranty extends the period of limitations contained in the General Conditions. The installer warranty will be countersigned by the installer and the manufacturer. The installer warrants the work of this section to be in accordance with the Contract Documents and free from faults and defects in materials and workmanship for a period of one (1) year.

PART 2 PRODUCTS

2.1 FLOOR HEATING SYSTEM

A. Manufacturer

1. Basis of Design Manufacturer: Subject to the compliance with requirements, provide nVent NUHEAT floor heating products courtesy of nVent Thermal Management, LLC Richmond, BC

   Phone: 800-778-9276

   Email: RES.customercare@nvent.com

   Website: www.nuheat.com

2. Provide specified product; Owner will not consider substitution requests.

B. Materials

1. Floor Heating Mat(s)
   a. Floor Heating Mat(s) should be shown in the drawings, carefully defining required locations, dimensions, and heights.
   b. Thermostat(s) should be shown in the drawings, carefully defining required location(s).
   c. Where indicated on the drawings and elsewhere as required, provide a heating mat using one of those listed on the "Tested Materials" list of the Underwriter's Laboratory (UL) or the Canadian Standards Association (CSA) or provide a similar system approved in advance by the Architect.
   d. Basis-of-Design Products:
      1) nVent NUHEAT Mat
         a) Electric radiant floor heating system consisting of a resistance heating wire bonded in a pre-configured pattern between two porous layers of fabric.
         b) The pre-formed electric floor heating product is manufactured to fit the shape of the heated floor area, without the need for on-site alterations or configuration, to ensure evenly distributed warmth throughout the floor.
         c) Heating product thickness shall not exceed 1/8 inch (3.2 mm).
         d) The system must be protected by a minimum, non-prorated, 25-year warranty.
         e) The system must be approved for use under ceramic tile, marble, other natural stone, laminate, engineered wood, and luxury vinyl floor coverings.
      2) nVent NUHEAT Signature Thermostat
         a) Technical details:
            - Dual voltage: 120/240 Volts AC at 60 Hz.
            - 15 A maximum (resistive load)
            - 1800 W at 120 V, 3600 W at 240 V
            - Class A GFCI (5 mA trip level)
            - UL C/US Approved/Listed

- Wi-Fi Enabled: 802.11 b/g/n
- 7-day programmability
- 10K Ω floor sensing probe
- Built-in ambient air temperature sensor
- Provision to allow user to limit floor temperature to 82 deg F (28 deg C) for laminate, engineered wood, or luxury vinyl floor coverings
- Remotely operable via free iOS and Android apps or a web portal that offers control multiple thermostats for different zones/rooms/homes
- Control integrations for smart home products including Amazon Alexa, Google Assistant, Google Nest, IFTTT, Control4, and custom integration using Open API
- Tracks and displays hourly, weekly, and monthly energy usage.
- Compatible with any electric floor heating system using 10K Ω floor sensor
- English/French/Spanish display language options
- 12-hour and 24-hour clock display options
- Fahrenheit and Celsius temperature display options
- Adjustable screen brightness

b) The thermostat must be protected by a minimum, non-prorated, 3-year warranty

2. Approval
   a. All system components shall be UL Listed and CSA Certified for floor heating.
   b. All system components shall come with an installation and operation instructions.

PART 3 EXECUTION

3.1 EXAMINATION

A. Substrate Examination
   1. Verify that subfloor structures to be covered with floor heating product(s) and floor covering materials are sound, conform to accepted design/engineering practices, and are sufficiently rigid with maximum deflection of L/360 distributed uniformly over the span.
   2. Concrete shall be cured a minimum of twenty-eight (28) days at 70°F with a saturated surface dry (SSD) condition, including an initial seven (7) day period of wet curing prior to installation of the floor heating system.
   3. Concrete slab(s) to have steel trowel or light broom finish when floor heating system is to be installed using thin-set mortar.
   4. Substrate must be clean and free of dirt, oil, grease, sealers, curing compounds, form oil, loose plaster, paint, and scale in order to install the floor heating system.

3.2 PREPARATION

A. Examine the areas and conditions under which work described in this section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

B. Coordinate with other trades as needed to assure that proper substrata are provided to receive the work of this section.
   1. Horizontal surfaces shall be level within one quarter of an inch (1/4") for every ten feet (10') in all directions.

C. Condition of surfaces to receive floor heating (product(s):
   1. Verify that surfaces to receive mortar setting bed and floor heating product(s) are firm, dry, clean, and free from dust, wax, grease, sealers, and all other contamination which may reduce or prevent adhesion.
   2. Verify that the concrete has been heavily scarified if curing compounds have been used.
   3. Verify that grounds, anchors, plugs, recess frames, bucks, electrical work, mechanical work, and similar items under the floor heating product(s) have been installed before proceeding with the installation of the floor heating product(s).
   4. Advise General Contractor and Architect of any surface or substrate conditions requiring correction before tile work commences. Beginning of work constitutes acceptance of substrate or surface conditions.

3.3 INSTALLERS

A. Acceptable Installers
   1. Subject to compliance with requirements of Contract Documents, installer shall have minimum one (1) year documented experience with installations of similar scope, materials, and design.

3.4 INSTALLATION

A. General
   1. Comply with pertinent provisions of the referenced standards, except as otherwise directed by the architect or specified herein.
   2. Maintain minimum temperature limits and installation practices recommended by materials manufacturers.

B. Do not begin installation of the floor heating product(s) until it has been tested and accepted.

1. To confirm the proper power consumption of the floor heating product(s) and to confirm that there is no short to ground, perform the insulation and resistance test on the ground braid and each conductor wire as per installation instructions provided. Ensure that the resistance reading is within the range of plus 10% to minus 5% of the resistance rating listed on the product tag(s) as per installation instructions provided with the floor heating product(s). Mark the test results on the warranty card provided and ensure they match manufacturer's recorded information on the floor heating product tag(s) as per installation instructions provided with the floor heating product(s). If system does not pass insulation and resistance testing, contact nVent NUHEAT technical services at (800) 778-9276.

C. Install according to TCNA installation methods and written instructions
   1. TCNA #RH 130 EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar
   2. TCNA #RH 135 Cementitious Backer Units/Fibre Cement Underlayment
   3. Floor Warming Systems UL 1693; CSA-C22.2 No.130-03; NEC Article 424

D. Subfloor – 19/32" exterior-glue plywood on joists every 16" on center. Gaps between plywood sheets to be treated per setting material manufacturer's recommendations.

E. Electrical connections shall be performed by a licensed electrician or otherwise appropriately qualified electrical contractor.

F. Apply coat of polymer-modified thinset mortar to the subfloor using a quarter-inch (1/4") square notched trowel. Roll the floor heating mat(s) into the thinset material. Using a grout float, smooth out all air bubbles or folds. Ensure bond between floor heating mat(s) and thinset conforms to at least 80% coverage.

G. Perform a second resistance and insulation test on the floor heating product(s) prior to installation of floor covering products as described above in 3.4 (B) (1). If system does not pass insulation and resistance testing, contact nVent NUHEAT technical services at (800) 778-9276.

H. Route the cold lead wires to the thermostat location and install the thermostat sensor probe wire as described in the installation instructions provided with the floor heating system.

I. Install compatible floor covering materials according to architectural specifications sections.

3.5 CONNECTIONS

A. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.6 PROTECTION

A. Protect finished installation. Close areas to other trades and traffic until floor covering materials has set and/or cured correctly. Keep traffic off horizontal Portland cement thick bed mortar installations for at least seventy-two (72) hours at 70°F (21°C).

B. Replace or restore work of other trades damaged or soiled by work under this section.

END OF SECTION

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DIVISION 26 – ELECTRICAL INDEX

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SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes general administrative and procedural requirements for Electrical installations. The administrative and procedural requirements specified herein are included in this Section to expand the requirements specified in Division 01.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

B. This section is a part of each Division 26 Section.

1.3 SUSTAINABLE DESIGN REQUIREMENTS

A. Implement practices and procedures to meet the project's environment goals which include achieving LEED (Leadership in Energy and Environmental Design) green building certification. Ensure that the requirements related to these goals, as defined in Division 01 and this section are implemented to the fullest extent. It is the Contractor's responsibility to refer to the applicable LEED version being followed for this project and comply with the specific requirements. The Contractor shall inform the Architect and LEED Consultant should proposed substitutions or changes affect the stated LEED requirements. Substitutions, or other changes to the work proposed by the contractor or their Subcontractors, shall not be allowed without express written consent of the Architect and LEED Consultant.

1.4 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and as specified in Division 01 Section titled "SUBMITTALS."

B. Prior to purchasing any equipment or materials, a list of their manufacturers shall be submitted for review.

C. Prior to assembling or installing the work, the following shall be submitted for review:

1. Scale drawings indicating insert and sleeve locations.

2. Scale drawings showing all cable trays, major conduit duct banks, individual conduit runs of 2-1/2 inch and larger with sizes, elevations and appropriate indication of coordination with other trades. This submission to us shall consist of an electronic file submittal and 2 paper prints.

3. Catalog information, factory assembly drawings and field installation drawings as required for a complete explanation and description of all items of equipment.

4. Coordination drawings for access panel and door locations.

D. Documents will not be accepted for review unless:

1. They include complete information pertaining to appurtenances and accessories.

2. They are submitted as a package where they pertain to related items.

3. They are properly marked with service or function, project name, where they consist of catalog sheets displaying other items which are not applicable.

4. List of all deviations and exceptions from the specified requirements for the product is provided on the first sheet of the submittal.

5. They indicate the project name and address along with the Contractor's name, address and phone number.

6. They are properly marked with external connection identification as related to the project where they consist of standard factory assembly or field installation drawings.

E. Shop Drawing Review

1. The purpose of the review of shop drawings is to maintain integrity of the design. Unless the contractor clearly points out changes, substitutions, deletions or any other differences between the submission and the Contract Documents in writing on the Contractor's letterhead, review by the Engineer or Architect does not constitute acceptance. It is not to be assumed that the engineer has read the text nor reviewed the technical data of a manufactured item and its components including where the Vendor has pointed out differences between his product and the specified model.

2. Upon receipt of the approved manufacturers and material suppliers list, the Contractor shall immediately obtain complete Shop Drawings, Product Data and Samples and equipment and material Specification Compliance Review documents from the manufacturers, suppliers, vendors and all Division 26 Contractors, for all materials and equipment as specified herein in various sections of the specifications and shall submit data and details of such materials and equipment for review by the Architect and Engineer. Prior to submission of the Shop Drawings, Product Data and Samples to the Architect and Engineer, the Contractor shall thoroughly review the Shop Drawings, Product Data and Samples and certify they are in compliance with the Contract Documents. The Contractor shall provide a compliance review ("Compliance Review") of the applicable Drawings, Specifications and Addenda for all equipment and materials. The Compliance Review will be a paragraph by paragraph review of the Specifications with the following information marked for each Specification section paragraph or in the margin of the original Specification and any subsequent Addenda.

a. "C": Comply with no exceptions.
b. "D": Comply with minor deviations. For each and every deviation, provide a numbered footnote with reasons for the proposed deviation and how the intent of the Specification can be satisfied.

c. "E": Exception. Equipment, product or material does not comply. For each and every exception, provide a numbered footnote with reasons for each exception and suggest possible alternatives for the owner's consideration.
d. "N/A": The specification paragraph does not apply to the proposed equipment, material or product.
e. Unless a deviation or exception is specifically noted in the Compliance Review, it is assumed that the Contractor is in complete compliance with the Contract Documents. Deviations or exceptions taken in cover letters, subsidiary documents, by omission or by contradiction does not relieve the Contractor from being in complete compliance unless the exception or deviation has been specifically noted (explicitly, not by implication) in the Compliance Review.

3. It is the responsibility of the contractor to confirm all dimensions, quantities, and the coordination of materials and products supplied by him with other trades. Review of shop drawings containing errors does not relieve the contractor from making corrections at his expense.

4. Substitutions of equipment, systems, materials, temperature controls must be coordinated by the Contractor with his own or other trades which may be involved with the item, such as, but not limited to, equipment substitutions which change electrical requirements, or hanging or support weights or dimensions.

5. Any extra changes or credits which may be generated by other trades due to substitutions will not be accepted unless the Contractor has an agreement in writing with the Owner.

6. Proposed substitutions shall be in accordance with the requirements of the section governing substitutions. Substitutions of equipment, systems, etc. requiring approval of local authorities must comply with such regulations and be filed at the expense of the Contractor (should filing be necessary). Substitutions are subject to approval or disapproval by the Engineer. The contractor in offering substitutions shall hold the Owner and Engineer harmless if the substituted item is an infringement of patent held by the specified item.

F. Explanation of Shop Drawing Stamp

1. Reviewed - No Exception Taken: indicates that we have not found any reason why this item should not be acceptable within the intent of the contract documents.

2. Exception Taken As Noted: indicates that we have found questionable components which if corrected or otherwise explained make the product acceptable.

3. Revised and Resubmit: indicates that this item should be resubmitted for review before further processing.

4. Resubmit Specified Item: indicates that the item will not meet the intent of the Contract.

5. Incomplete - Resubmit: Indicates that the submission is not complete and ready for review by the Architect or Engineer.

6. Verified for Electrical Services: Indicates that the electrical requirements have been confirmed with the electrical contract documents.

7. Architects Review Required: Indicates that the submission will required the Architects review.

8. Structural Review Required: Indicates that the submission will require the Structural Engineer's review.

9. Acoustical Consultant Review Required: Indicates that the submission will require the acoustical consultant's review.

10. No shop drawing stamp or note shall constitute an order to fabricate or ship. Such notification can only be performed by the Project Manager for Construction, the Contractor scheduling his own work, or the Owner.

11. The Contractor is responsible for having "Reviewed" copies of shop drawings bearing the "Reviewed - No Exception Taken" stamp of the Architect/Engineer or Owner's Consultant are kept on the job site and work is implemented in the field in accordance with these documents.

12. Where information from one Contractor is required by another contractor, it is the responsibility of the contractors to exchange information and coordinate their work.

1.5 QUALITY ASSURANCE

A. Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code Steel" (where required)

B. Products Criteria:

1. All equipment furnished as part of the work shall comply with the latest editions of all applicable state and municipal "energy codes." Provide certification from the equipment suppliers for all energy-consuming equipment that the equipment fully complies with these codes. Equipment submissions will not be accepted for review unless accompanied by such certification in writing.

2. All equipment and materials shall be new and without blemish or defect.

3. All equipment and materials shall be free of asbestos.

4. Electrical equipment and materials shall be products which will meet with the acceptance of the agency inspecting the electrical work. Where such acceptance is contingent upon having the products examined, tested and certified by Underwriters or other recognized testing laboratory, the product shall be examined, tested and certified.. Where no specific indication as to the type or quality of materials or equipment is indicated, a first class standard article shall be furnished.

5. It is the intent of these specifications that wherever a specific manufacturer of a product is specified or scheduled, and the specifications include other approved manufacturers or the terms "other approved" or "or approved equal" or "equal" are used, the submitted item must conform in all respects to the specified item. Consideration will not be given to claims that the submitted item meets the performance requirements with lesser construction. Performance as delineated in schedules and in the specifications shall be interpreted as minimum performance.

6. All equipment of one type shall be the products of one Manufacturer.

7. Substituted equipment or optional equipment where permitted and approved, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether approved or not, shall be replaced at the Contractor's expense. Any modifications of related systems as a result of substitutions shall be made at the Contractor's expense.

8. Note that the approval of shop drawings, or other information submitted in accordance with the requirements hereinbefore specified, does not assure that the Engineer, Architect, or any other Owner's Representative, attests to the dimensional accuracy or dimensional suitability of the material or equipment involved or the ability of the material or equipment involved or the mechanical performance of equipment. Approval of Shop Drawings does not invalidate the plans and specifications if in conflict, unless a letter requesting such change is submitted and approved on the Engineer's letterhead.

9. Substitutions of Electrical Equipment for that shown on the schedules or designated by model number in the specifications will not be considered if the item is not a regular cataloged item shown in the current catalog of the manufacturer.

C. Manufacturer's Recommendations: Where installation procedures of any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

1.6 COORDINATION

A. Arrange for conduit spaces, chases, slots, and openings in building structure during progress of construction, to allow for electrical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for electrical items requiring access that are concealed behind finished surfaces.

D. Provide all designating signs for safety switches, overcurrent devices, controls, alarms, and the like, as required by the agencies having jurisdiction.

1.7 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with Division 01 Section titled "PROJECT COORDINATION" to a scale of 3/8 inch =1'-0 inch (1:75) or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components in spaces such as electric switchgear room, emergency generator room, UPS room, and electric closets. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. The coordination drawings shall be produced using AutoCad 2011 or later software. The design drawings will be made available on disks in AutoCad format for use as a basis for the "Coordination" drawings. These documents remain the property of Cosentini Associates and shall be used for no other purpose without expressed, written consent. The contractor shall assume all liabilities resulting from unauthorized use or modifications to the drawings.

2. Indicate the proposed locations of major raceway systems, equipment, and materials. Include the following:

   a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.

   b. Exterior wall and foundation penetrations.

   c. Fire-rated wall and floor penetrations.

   d. Equipment connections and support details.

   e. Sizes and location of required concrete pads and bases.

3. Indicate conduit banks, concrete encased conduit banks, cable trays, individual raceway (conduit) runs larger than 3 inch, etc. loads and support points and submit to the Structural Engineer for review and approval. Indicate the elevation, location, support points, and loads imposed on the structure at support, anchor points, and size of all lines. Indicate all beam penetrations and slab penetrations sized and coordinated. Indicate all work routed underground or embedded in concrete by dimension to column and building lines.

4. Identify all equipment and systems that are installed as part of the work of this Division that by Code require seismic restraint.

5. Indicate seismic support and restraint for all piping and equipment installed as part of the work of this Division and specified under another section of Division 21

6. Identify all equipment and systems installed as part of the work of this Division that by Code does not require seismic restraint whose failure in a seismic event will cause the failure of life safety, high hazard or essential facilities systems installed as part of the work of this Division or restrained equipment and systems installed as part of the work of other Divisions.

7. The equipment and systems identified that by Code do not require seismic restraint whose failure may result in failure of equipment and systems (installed as part of the work of this Division or the restrained equipment and systems installed as part of the work of other Divisions) requiring seismic restraint due to their proximity and relative position shall be seismically restrained.

8. Indicate seismic support and restraint for equipment and system identified in 6 & 7 above.

9. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

10. Prepare floor plans, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

11. Prepare reflected ceiling plans to coordinate and integrate sprinkler installation, air outlets and inlets, light fixtures, communication systems components and other ceiling-mounted items.

B. Project Coordination Drawings

1. This Trade shall add to Coordination Drawings prepared by the HVAC Contractor showing all of the electrical work (equipment, conduit, etc.) to be installed as part of the work of this section of the specifications.

2. All seismic supports and restraints as part of the seismic design (as outlined under another section of this work) shall be shown on the coordination drawings.

3. The Coordination Drawings shall be prepared on electronic media (CADD) at not less than 3/8": 1'-0" scale

4. Requirements for vibration isolation shall be shown on the coordination drawings by each trade.

5. This Trade after showing all of the electrical work shall forward the completed reproducible Coordination Drawings to the General Contractor/Construction Manager.

6. The Electrical Contractor shall attend a series of meetings arranged by the General Contractor/Construction Manager to resolve any real or apparent interferences or conflicts with the work of the other Contractors.

7. The Electrical Contractor shall then make adjustments to his work on the Coordination Drawings to resolve any real or apparent interferences or conflicts.

8. After any real or apparent interferences and conflicts have been incorporated into the Coordination Drawings, the Electrical Contractor shall "sign-off" the final Coordination Drawings.

9. The Electrical Contractor shall not install any of this work prior to "sign-off" of final Coordination Drawings. If the electrical work proceeds prior to sign-off of Coordination Drawings, any change to the electrical work to correct the interferences and conflicts that result will be made by the Electrical Contractor at no additional cost to the project.

10. Coordination Drawings are for the Electrical Contractor's and Owner's use during construction and shall not be construed as replacing any shop, as-built, or Record Drawings required elsewhere in these Contract Documents.

11. Review of Coordination Drawings shall not relieve the HVAC Contractor from his overall responsibility for coordination of all work performed pursuant to the Contract or from any other requirements of the Contract.

1.8 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 01. In addition to the requirements specified in Division 01, comply with the following:

1. A complete set of "as-built" or record electric drawings shall be made up and delivered to the Architect.

2. The drawings shall show:

a. All electric work installed exactly in accordance with the original design.

b. All electric work installed as a modification or addition to the original design.

c. The dimensional information necessary to delineate the exact location of all circuitry and wiring runs (other than lighting and appliance branch circuitry and small control, signal and communications runs) that are so buried or concealed as to be untraceable by inspection through the regular means of access established for inspection and maintenance.

d. The numbering information necessary to correlate all electrical energy consuming items (or outlets for same) to the panel or switchboard circuits from which they are supplied.

3. The documents shall be produced using BIM software in accordance with the requirements of Division 1.

4. The drawings shall be produced using AutoCAD software. The design drawing files will be made available should it be determined that such files would serve as suitable backgrounds for the "as-built" drawings. These documents remain the property of Cosentini Associates and may be used for no other purpose without expressed, written consent. The contractor shall assume all liabilities resulting from unauthorized use or modifications to the drawings.

5. Prior to developing any "as-built" drawings, the Contractor shall coordinate with the Owner, Architect, Engineer and other Contractors the drawing layers, colors, etc. of the CAD drawings

6. CAD files shall each correspond to a single drawing sheet and have all of the x-refs bound to the file. CAD fonts that are not in the standard AutoCAD group shall be embedded into the DWG file.

7. "As-built" information shall be submitted as follows:

   a. CADD drawing files on CD-R or DVD-R in AutoCAD format.

   b. One (1) set of reproducible drawings.

   c. Two (2) sets of blueprints.

8. The quantity of design drawings that are made available shall in no way be interpreted as setting a limit to the number of drawings necessary to show the required "as-built" information.

9. Progress prints of record drawings shall be submitted monthly during the construction period for Architect's approval.

10. As-built drawings for filing with the Building Department (where required) shall be prepared at the same scale, in the same plan format and use the same symbols and nomenclature as the plans filed by Engineer of Record with the Building Department for "Building Permit."

1.9 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 01. In addition to the requirements specified in Division 01, include the following information for major equipment items such as engine generator set(s), alarm system(s), communications systems, transformers, switchgear, panelboards, automatic transfer switches, lighting fixtures, and other items as specified elsewhere.

   1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

   2. Manufacturer's printed operating procedures include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions.

   3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

   4. Servicing instructions.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Unit shall be stored and handled in accordance with manufacturer's instructions.

C. Unit shall be shipped with all listed items and control wiring factory installed unless noted on the submittals and approved prior to shipment.

D. Unit shall be shipped complete as specified. Parts for field installation shall not be shipped and stored on site without prior approval.

E. Rigging: Units shall be fully assembled. Units requiring disassembly for rigging shall be factory assembled and tested. Disassembly, reassembly and testing shall be supervised by the manufacturer's representative.

F. Unit shall be shipped with firmly attached labels that indicate name of manufacturer, model number, serial number, and plan tagging.

G. The Vendor shall shrink wrap all electronic equipment and spare parts prior to shipping. Spare parts are to be delivered at time of owner acceptance.

H. Deliver, store and handle all materials to keep clean and protected from damage.

I. Store products in shipping containers and maintain in place until installation.

J. Protect equipment and other materials from damage after installed from construction debris and other damage.

1.11 CODES, PERMITS AND INSPECTIONS

A. All work shall meet or exceed the latest requirements of all national, state, county, municipal, and other authorities exercising jurisdiction over electrical construction work and the project.

B. All required permits and inspection certificates shall be obtained, paid for, and made available at the completion of the work.

C. Any portion of the work that is not subject to the requirements of an electric code published by a specific authority having jurisdiction shall be governed by the National Electrical Code and other applicable sections of the National Fire Code, as published by the National Fire Protection Association.

D. Equipment, material, layout and installation provided as part of the electrical work shall conform to the requirements of all agencies having jurisdiction. Include as part of the electrical work all required filings and submissions for approval. Equipment furnished separate from - but installed as part of - the electrical work, which does not have all necessary approvals, shall not be installed until approvals are obtained by the parties furnishing the equipment.

E. Installation procedures, methods and conditions shall comply with the latest requirements of the Federal Occupational Safety and Health Administration (OSHA).

F. All equipment furnished as part of the electrical work shall comply with the latest editions of all applicable state and municipal "energy codes."

1.12 GUARANTEES AND CERTIFICATIONS

A. All work shall be guaranteed to be free from defects. Any defective materials or workmanship as well as damage to the work of all trades resulting from same shall be replaced or repaired as directed for the duration of stipulated guaranteed periods.

B. The duration of guarantee periods following the date of beneficial use of the system shall be one year. Beneficial use is defined as operation of the system to obtain its intended use.

C. The date of acceptance shall be the date of the final payment for the work or the date of a formal notice of acceptance, whichever is earlier.

D. Non-durable items such as electric lamps, shall be replaced up to the date of acceptance, such that they shall have had no more than 100 hours use prior to this date.

E. Certification shall be submitted attesting to the fact that specified performance criteria are met by all items of electrical equipment for which such certification is required.

1.13 SEPARATION OF WORK BETWEEN TRADES

A. The specifications for the overall construction delineate various items of work under separate trade headings. The list below sets forth this delineation to the extent that it affects the electric work.

B. In the absence of more detailed information, the list shall be taken as a specific instruction to the electrical trade to include the work assigned to it.

C. Indications that any trade is to perform an item of work means that it is to perform the work for its own accommodation only, except as specifically noted otherwise.

Oth = Divisions other than Electrical (Division 26); Mechanical (Divisions 21, 22 & 23)

Plb = Plumbing

FP = Fire Protection

Htg = Heating, Ventilating & Air Conditioning

Elec = Electrical.

f = Furnished.

i = Installed.

p = Provided (furnished and installed).

Item	Oth	Plb	FP	Htg	Elec	Note
Motors for mechanical equipment.		p	p	p		
Motor controllers for: Htg Plb FP		 f 	 f	 f 	 i i i	Specifications and drawings delineate exceptions.
Motor control devices for: Htg Plb FP		 p 	 p	 p 		Specifications and drawings delineate exceptions. Control devices for mounting within controller are provided integral with controller.
Power wiring for motors: Htg Plb FP					 p p p	
Control wiring for motor controllers: Htg Plb FP				 p 	 p p	Specifications and drawings delineate exceptions.
Temporary light and power.	p					See General conditions specifications. To accommodate all trades.
Temporary water.	p					
Temporary heat.	p					

Item	Oth	Plb	FP	Htg	Elec	Note
Temporary toilets.	p					
Hoisting.					p	
Rigging.					p	
Bracing and dunnage for safe rigging.					p	
Cutting, chasing and patching.	p					Cost where due to late installation or improper coordination of work is the responsibility of electrical contractor.
Framed slots and openings in walls, decks and slabs.	p					Coordination drawings are required from the electrical contractor.
Sleeves through non-waterproof slabs, decks and walls.					p	Includes drilling of holes when required.
Sleeves through waterproof slabs, decks and walls.					p	Includes drilling of holes for other than field poured concrete.
Waterproof sealing of sleeves through waterproof slabs, decks and walls.					p	
Fireproof sealing (fire-stopping) excess opening spaces in slabs, decks and fire-rated walls.					p	
Excavation and backfill outside buildings.					p	
Concrete encasement of conduits.					p	Red coloring for concrete encasing primary voltage runs included in electric.
Fastenings.					p	
Supports.					p	

Item	Oth	Plb	FP	Htg	Elec	Note
Flashing of electric conduits through roof (pitch pockets).	p					
Concrete foundations, pads and bases inside buildings.	p					Furnishing of anchors and vibration mounts included in the electric.
Concrete foundations, pads and bases outside buildings.					p	Furnishing of anchors and vibration mounts included in the electric.
Concrete lined trenches in building foundation.	p					
Field touch-up painting of damaged shop coats.					p	
Field rustproof painting of supporting steel members, frames and racks.					p	
Finish painting of exposed work.	p					Red coloring of exposed fire protection alarm systems circuitry included in electric. Red and white striping of exposed primary voltage runs included in electric.
Finished Wall and Ceiling Access Doors and Supporting Frames	i				f	Contractor shall locate the doors on approved shop drawings and shall be held responsible for the accessibility of all concealed outlet boxes, pull boxes, controls, equipment, etc.
Opening frames for ceiling recessed lighting fixtures and other electrical items.					p	
Luminous ceilings.	p					Lamp strips and lamps included in electric.

Item	Oth	Plb	FP	Htg	Elec	Note
Electric heaters with integral fans, (unit heaters, cabinet heaters, fan coil units and the like.)				p		Line and control connections included in electric.
Electric water heaters.		p				Line and control connections included in electric.
Electric heater cables for radiant space heating.					p	
Electric heater cables for de-icing.					p	
Electric heater cables for mechanical system pipe tracing.					p	
Electric heater cables for domestic water temperature maintenance		p				Line and control connections included in electric.
Electric power consuming items and controls for same not referred to above.	p	p	p	p		Line and control connections to equipment included in electric.
Rubbish removal.					p	Removal of the shipping and packing materials of electrical items is included in the electric regardless by whom the items are furnished.
Special tools for maintenance of equipment furnished as part of electric work.					f	

D. Include in the electrical work all necessary supervision and the issuing of all coordination information to any other trades who are supplying work to accommodate the electrical installations.

E. For items of equipment that are to be installed but not purchased as part of the electrical work, the electrical work shall include:

1. The coordination of their delivery.

2. Their unloading from delivery trucks driven in to any point on the property line at grade level.

3. Their safe handling and field storage up to the time of permanent placement in the project.

4. The correction of any damage, defacement or corrosion to which they may have been subjected.

5. Their field make-up and internal wiring as may be necessary for their proper operation.

6. Their mounting in place including the purchase and installation of all dunnage, supporting members, and fastenings necessary to adapt them to architectural and structural conditions.

7. Their connection to building wiring including the purchase and installation of all "crown boxes" or other type of termination junction boxes necessary to adapt and connect them to this wiring. Included also shall be the purchase and installation of any substitute lugs or other wiring terminations as may be necessary to adapt their terminals to the building wiring as called for and to the connection methods set forth in these specifications.

F. Items of equipment that are installed but not purchased as part of the electrical work shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the electric work will be considered only if presented in writing within one week of the date of delivery to the project of the items in question. The electric work includes all procedures, regardless of how extensive, necessary to put into satisfactory operation, all items for which no claims have been submitted as outlined above.

1.14 DEFINITIONS AND INTERPRETATIONS

A. As used in the drawings and specifications for electrical work, certain non-technical words shall be understood to have specific meanings as follows regardless of indications to the contrary in the General Conditions or other documents governing the electric work.

1. "Furnish" – Purchase and deliver to the project site complete with every necessary appurtenance and support, all as part of the electrical work. Purchasing shall include payment of all sales taxes and other surcharges as may be required to assure that purchased items are free of all liens, claims or encumbrances. Payment of sales taxes is, however, specifically excluded.

2. "Install" – Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project, all as part of the electrical work.

3. "Provide" – "Furnish" and "install."

4. "New" – Manufactured within the past two years and never before used.

5. Regardless of their usage in codes or other industry standards, certain words as used in the drawings or specifications for the electrical work, shall be understood to have the specific meanings ascribed to them in the following list:

   a. "Circuitry" – Any electric work (not limited to light and power distribution) that consists of wires, cables, raceways, and/or specialty wiring method assemblies taken all together complete with associated junction boxes, pull boxes, outlet boxes, joints, couplings, splices and connections except where limited to a lesser meaning by specific description.

   b. "Wiring" – Same as Circuitry.

   c. "Circuit" – Any specific run of circuitry.

   d. "Branch Circuit" – Any light and power distribution system circuit that, at its load end, is directly connected to one or more electrical energy consuming items with no overcurrent protection devices interposed, other than (where required) those protecting the energy consuming items from overloading or overheating.

   e. "Appliance Panel" – Any panel, used in a light and power distribution system, containing single pole and/or multipole branches rated in various sizes.

   f. "Lighting Panel" – Any panel used in a light and power distribution system, having all (or the majority) of its branches single pole and rated the same.

   g. "Lighting and Appliance Branch Circuitry" – All or any portion of branch circuits outgoing from a lighting or appliance panel.

   h. "Feeder" – Any item of light and power circuitry used in a distribution system that is not lighting and appliance branch circuitry.

   i. "Main Feeder" – Any feeder that, at its supply end, is connected through its own overcurrent protection (and switching) device, and none other, directly to a main service or a main service overcurrent protection (and switching) device.

   j. "Branch Feeder" – A feeder, other than a main feeder, that complies with the definition of a branch circuit.

   k. "Submain Feeder" – Any feeder that is neither a main feeder nor a branch feeder.

   l. "Distribution Panel" – Any panel, used in a light and power distribution system, containing only multi-pole branches and with all (or the majority) of its branches used for feeders supplying other panels.

   m. "Power Panel" – Same as distribution panel, except with all (or the majority) of its branches used for feeders that do not supply other panels.

   n. "Motor Power Circuit" – Any circuit that operates nominally at 100 volts or more, and that carries electrical input energy to a motor.

o. "Motor Control Circuit" (used in conjunction with a motor for which a magnetic starter is supplied) – Any circuit (other than a motor power circuit) that operates nominally at 100 volts or more, and that carries current intended for directing or indicating the performance of a motor starter.

p. "Motor Control Circuit" (used in conjunction with a motor for which a manual starter is supplied) – Any circuit containing an extension of power circuit wires, other than those constituting the direct connection between source of supply, starter and motor.

q. "Motor Control Actuating Device" – Any device that performs a switching function in a motor control circuit (pushbuttons, automatic contacting devices, etc.).

r. "Motor Control Actuated Device" – Any device that functions in response to voltage received from a motor control circuit (pilot lights, solenoids, etc.)

s. "Package Unit" – An item of equipment having one or more motors or other electric energy consuming elements integrally factory mounted on a single base, complete with all associated control devices and interconnecting wiring.

t. "Low Voltage" – Below 50 volts.

u. "Process Control System" – An overall control and/or logging system available as a "package" from specialty manufacturers (commonly referred to as a "Temperature Control System" or an "Automatic Control System" or a "Building Management System").

v. "Grade Slab" – A building floor slab that is in contact with or directly over grade (earth).

w. "Building Confines" – The extent of a building, as defined by the outside surfaces of its peripheral walls, the top surface of its roof, and the underside surface of its grade slab.

x. "Distribution Switch" – Any switch used in a light and power system other than a tumbler, toggle or specialty switch in the "wiring device" category.

y. "Normal Electric Work Conditions" – Locations within building confines that are neither damp, wet nor hazardous and that are not used for air handling.

z. "Underground" – Subsurface and exterior to building foundations.

aa. "At Underside of Grade Slab" – Under a grade slab and integrated into it.

bb. "Below Grade Slab" – Under a grade slab but not integrated into it.

cc. "Standard" (as applied to wiring devices) –- Not of a separately designated individual type.

dd. "Raceway" – Any pipe, duct, extended enclosure, or conduit (as specified for a particular system) that is used to contain wires, and that is of such nature as to require that the wires be installed by a "pulling in" procedure.

ee. "Concealed" (as applied to circuitry) – Covered completely by building materials, except for penetrations (by boxes and fittings) to a level flush with the surface as necessitated by functional or specified accessibility requirements.

ff. "Exposed" (as applied to circuitry) – Not covered in any way by building materials.

gg. "Subject to Mechanical Damage" – Exposed within seven feet of the floor in mechanical rooms, or spaces where heavy items (over 100 pounds) are moved around or rigged as a common practice or as required for replacement purposes.

hh. "Primary" (as applied to light and power distribution) – Over 600 volts.

ii. "Secondary" (as applied to light and power distribution) – Under 600 volts.

jj. "Assembly" – A defined set of elements of electric work.

B. The following shall be treated as damp or wet locations within building confines, regardless of whether or not a high ambient moisture level is found to exist:

1. Spaces where any designations indicating weatherproof (WP) or vapor-proof (VP) appear on the drawings.

2. Below waterproofing in slabs applied directly on grade.

3. Outside of waterproofing in foundation walls in contact with grade.

4. Above waterproofing in slabs having no building above.

5. Above waterproofing in fill on slabs having no building above.

C. Electric work in slabs, walls or suspended ceilings that bound on a space defined as a damp or wet location shall meet the damp or wet location requirements if it enters into, or opens into the damp or wet location in any way.

D. Where the word "conduit" is used without specific reference to type, it shall be understood to mean "raceway".

E. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any electrical item in the drawings and specifications for electrical work carries with it the instruction to furnish, install and connect the item as part of the electrical work regardless of whether or not this instruction is explicitly stated.

F. It shall be understood that the specifications and drawings are complementary and are to be taken together for a complete interpretation of the work. Where there are conflicts between the drawings and specifications or within the specifications or drawings themselves, the items of higher standard shall govern.

G. To the extent that they govern the basic work, the specifications also govern change order work if any.

H. No exclusion from or limitation in, the symbolism used on the drawings for electrical work or the language used in the specifications for electrical work shall be interpreted as a reason for omitting the appurtenances or accessories necessary to complete any required system or item of equipment.

I. The drawings for electrical work utilize symbols and schematic diagrams that have no dimensional significance. The work shall, therefore, be installed to fulfill the diagrammatic intent expressed on the electrical drawings, but in conformity with the dimensions indicated on the final working drawings, field layouts and shop drawings of all trades. In particular, information as to the exact size, location and electrical connection points for mechanical equipment shall be derived by reference to HVAC and Plumbing documents.

J. Certain details appear on the drawings for electrical work that are specific with regard to the dimensioning and positioning of the work. These are intended only for general information purposes. They do not obviate field coordination for individual items of the indicated work.

K. Information as to general construction and architectural general construction and architectural features and finishes shall be derived from structural and architectural drawings and specifications only.

L. The use of words in the singular shall not be considered as limiting where other indications denote that more than one item is referred to.

M. Ratings of devices, materials and equipment specified without reference to specific performance criteria shall be understood to be nominal or nameplate ratings established by means of industry standard procedures.

N. The restriction of conductors in wires to copper, as specified elsewhere, shall be understood to also apply to all conductors (wire, cable or bus as applicable), including those provided as part of factory assembled components such as transformers, switchboards, panelboards, switchgear, overcurrent protection and switching devices. This restriction shall apply equally to all such equipment regardless of indications (or lack thereof) elsewhere to the contrary. Aluminum will not be acceptable.

1.15 PRECONSTRUCTION CONFERENCE PRIOR TO START OF WORK

A. Prior to commencing any Work, the CM, together with designated major Contractors, shall confer with the Architect and Engineer concerning the Work under the Construction Contract.

B. The pre-construction conference will be conducted under the leadership of the CM and will occur soon after the CM notifies the Subcontractors of contract award. The pre-construction conference will focus on items such as the expedited submittal review procedure, interface and coordination between Contractor work scope, the CM's project site rules and requirements, temporary utility requirements, CM's construction schedule, etc.

1.16 SEQUENCING AND SCHEDULING

A. Coordinate electrical equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

C. Coordinate the installation of required supporting devices and set sleeves in poured in place concrete and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

E. Coordinate connection of mechanical services.

F. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

G. Coordinate requirements for access panels and doors where electrical items requiring access are concealed behind finished surfaces. See paragraph titled “Separation of Work Between Trades” to determine whether access panels and doors the responsibility of the Contractor for Division 08 or the Contractor responsible for Division 26

H. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.

1.17 SEISMIC DESIGN

A. Coordinate With Section 230547 Vibration Controls For Mechanical/Electrical (Non-Seismic).

1.18 EXAMINATION OF SITE AND CONTRACT DOCUMENTS

A. Before submitting prices or beginning work, thoroughly examine the site and the Contract Documents.

B. No claim for extra compensation will be recognized if difficulties are encountered which examination of site conditions and Contract Documents prior to executing Contract would have revealed.

1.19 WORKMANSHIP

A. The entire work provide in this Specification shall be constructed and finished in every aspect in a workmanlike and substantial manner.

B. It is not intended that the Drawings shall show every raceway, conduit, fitting, equipment and appliance. Electrical Contractor shall furnish and install all such parts as may be necessary to complete the systems in accordance with the best trade practice.

C. Keep other trades fully informed as to shape, size and position of all openings required for apparatus and give full information to the General Contractor and other trades in a timely manner so that all opening may be built in advance. Furnish and install all sleeves, supports and the like as specified or as required.

D. In case of failure on the part of the Electrical Contractor to give proper and timely information as required above, he shall do his own cutting and patching or have same done by the General Contractor, but in any case, without extra expense to the Owner.

E. Obtain detailed information from the manufacturers of apparatus as to the proper method of installing and connecting same. Obtain all information from the General Contractor and other trades which may be necessary to facilitate work and completion of the whole project.

PART 2 - PRODUCTS

2.1 EQUIPMENT TOUCH UP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

2.2 ACCESS DOORS IN FINISHED CONSTRUCTION

A. Access doors as required for operation and maintenance of concealed equipment, boxes, controls, etc. will be provided as part of the work of Division 08.

B. This Contractor is responsible for access door location, size and its accessibility to the boxes, controls, equipment, etc. being served.

C. Coordinate and prepare a location, size, and function schedule of access doors required and deliver to a representative of the Contractor for Division 08.

D. Furnish and install distinctively colored buttons in finished ceiling.

E. Access doors shall be of ample size to perform proper maintenance on concealed equipment, boxes, controls, etc. but shall not be less than a minimum of 18-inches x 18-inches for installation in walls and a minimum of 22-inches x 22-inches for installation in ceilings.

F. Construct doors and frames to comply with the requirements of the NFPA and Underwriters Laboratories Inc. for fire rating. Install UL label on each door in a non-exposed location unless otherwise required by the local authority having jurisdiction.

PART 3 - EXECUTION

3.1 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in Divisions 02 through 28 for rough-in requirements.

3.2 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with other building components.

2. Verify all dimensions by field measurements.

3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.

4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect.

8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

9. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

10. Coordinate location of access panels or doors where outlet boxes, junction boxes, or equipment are concealed behind finished surfaces.

11. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

B. Coordinate electrical service connections to components furnished by others.

1. Coordinate installation and connection of exterior underground utilities and services, with facility Engineer.

2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

C. Locations of all devices, fixtures, and other visible components shall be as indicated on the architectural drawings. Mounting heights shall be as specified in Division 26 Section "Raceways and Boxes".

D. Each piece of mechanical equipment located outside the building or on the roof shall be within 25 feet (7 m) of a duplex receptacle. Where necessary to meet these criteria, provide duplex receptacles in addition to those devices shown on the drawings. Each shall be complete with waterproof cover and integral GFI protection, and 20 ampere circuitry to the nearest 120 volt panel.

E. Provide a duplex receptacle in each room containing switchgear, switchboards or panelboards. Where necessary to meet these criteria, provide duplex receptacles in addition to those devices shown on the drawings. Each shall be complete with 20 ampere circuitry to the nearest 120 volt panel not served from the equipment within the room (other than for service equipment).

F. Include electrical work as required for reading of water meters, as described in Plumbing drawings and Division 23 specifications.

G. Include electrical work as required for reading of steam meters, as described in HVAC drawings, Division 23 specifications, and Utility Company standards and related documents.

3.3 FIRE-STOPPING

A. Refer to Division 08 titled "Thermal and Moisture Protection" for fire-stopping requirements.

B. Contractor responsible for the work of Division 26 shall be responsible for fire-stopping of all work installed as part of the work of Division 26.

C. Fire-stopping system must be U.L. approved.

D. All spaces between raceways, conduit, etc. and their respective sleeves or fire-rated construction shall be packed full depth with an approved fire resistant material, compressed firmly in place. Fiberglass shall not be used. Sleeve clearances shall not exceed 2 inches between raceways, conduits, etc. and sleeves.

E. Fire-stopping material and installed configuration shall maintain the fire rating of the penetrated wall or ceiling.

3.4 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 01 Section "Cutting and Patching." In addition to the requirements specified in Division 01, the following requirements apply:

1. Perform cutting, fitting, and patching of electrical equipment and materials required to:

   a. Uncover Work to provide for installation of ill-timed Work.

   b. Remove and replace defective Work.

   c. Remove and replace Work not conforming to requirements of the Contract Documents.

   d. Upon written instructions from the Architect, uncover and restore Work to provide for Architect observation of concealed Work.

   e. Install equipment and materials in existing structures.

2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.

3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

4. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

5. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers.

   a. Refer to Division 01 Section "Definitions and Standards" for definition of experienced "Installer."

6. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers.

7. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

   a. Refer to Division 01 Section titled “References” for definition of "experienced Installer."

3.5 CONNECTIONS TO EXISTING WORK

A. Plan installation of new work and connections to existing work to ensure minimum interference with regular operation of existing facilities. Submit to the Owner for approval, date schedule of necessary temporary shut-downs of existing services. All shutdowns shall be made at such times as will not interfere with regular operation of existing facilities and only after written approval of Owner. To ensure continuous operation, make necessary temporary connections between new and existing work. All costs resulting from temporary shut-downs shall be borne by this Contractor.

B. The drawings of necessity utilize symbols and schematic diagrams to indicate connections to existing work. Neither of these have any dimensional significance nor do they delineate every item required for the intended installations.

C. The contractor shall coordinate all connections to existing work with the facility engineer. Contractor shall field verify exact location of all existing services.

D. Connect new work to existing work in neat and approved manner. Restore existing work disturbed to original condition.

3.6 REFINISHING AND TOUCH UP PAINTING

A. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.

B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

C. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

D. Repair damage to PVC or paint finishes with matching touch up coating recommended by manufacturer.

3.7 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Cutting and patching for electrical construction.

2. Touch up painting.

3.8 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 26 05 00

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SECTION 26 05 13 - MEDIUM VOLTAGE CABLES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

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

1. Section 26 05 00 “Common Work Results for Electrical”.

2. Section 26 13 00 “Medium-Voltage Switchgear.”

3. Section 26 05 53 “Electrical Identification.”

1.3 DEFINITIONS

A. MV: Medium-voltage.

B. NETA: ATS: Acceptance Testing Specification.

C. EPR: Ethylene Propylene Rubber.

D. XLP or XLPE: Cross- Linked Polyethylene.

E. PVC: Polyvinyl Chloride.

F. ICEA: Insulated Cable Engineers Association.

G. NEMA: National Electrical Manufacturers Association.

H. AEIC: Association of Edison Illuminating Companies.

I. CPSE: Chlorosulfonated Polyethylene.

1.4 SUBMITTALS

A. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.

B. Material Certificates: For each cable and accessory.

C. Source quality-control test reports.

D. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

B. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C2 and NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Cable shall be shipped on manufacturers reels and protected from weather and mechanical injury.

B. Each cable end shall be hermetically sealed with manufacturers end caps and securely attached to the reel.

C. Cut cable lengths stored on site shall have the manufacturers standard end cap or field installed heat-shrink cable end seals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, by the following manufacturer unless approved otherwise by Regeneron.

1. Cables:

a. Southwire

2. Cable Splicing and Terminating Products and Accessories:

a. G&W Electric Co.

b. Thomas & Betts/Elastimold.

c. 3M Company; Electrical Products Division.

d. Mac Products, Inc.

e. Raychem, Tyco Electronics.

2.2 CABLES

A. Cable Type: MV-105.

B. Conductor: Copper.

C. Conductor Stranding: Compact round, concentric lay, Class B.

D. Strand Filling: Conductor interstices are filled with impermeable compound.

E. Conductor Insulation: Crosslinked polyethylene complying with AEIC CS 8.

1. Voltage Rating: 15 KV.

2. Insulation Thickness: 133 percent insulation level.

F. Shielding: Copper tape or solid copper wires helically applied over semiconducting insulation shield.

2.3 SPLICE KITS

A. Splice Kits and Connectors: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

2.4 SOLID TERMINATIONS

A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone-rubber, insulator modules; shield ground strap; and compression-type connector.

2. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.

3. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.

4. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.

5. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape; cold-shrink-rubber sleeve; or heat-shrink, plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

6. Class 3 Terminations: Kit with stress cone and compression-type connector.

2.5 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: 10-mil (250-micrometer) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, ½ inch (13 mm) wide.

2.6 SPLICE KITS

A. Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

1. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.

2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.

3. Premolded, cold-shrink-rubber, in-line splicing kit.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ISEA S-97-682 before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches (1200 to 1800 mm) on the pull rope.

1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.

2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.

2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.

4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

D. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

E. Install direct-buried cables on leveled and tamped bed of 3-inch- (75-mm-) thick, clean sand. Separate cables crossing other cables or piping by a minimum of 2 inches (50 mm) of tamped earth, plus an additional 2 inches (50 mm) of sand. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

F. Install "buried-cable" warning tape 12 inches (305 mm) above cables.

G. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.

H. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

I. Install cable splices at pull points and elsewhere as indicated; use standard kits. Use dead-front separable watertight connectors in manholes and other locations subject to water infiltration.

J. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.

K. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.

2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.

3. Standoff Insulator: At each terminal junction, with one on each terminal.

L. Seal around cables passing through fire-rated elements according to Section 07 84 13 "Penetration Firestopping."

M. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

N. Identify cables according to Section 26 05 53 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.

2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

3. Perform direct-current High Potential test of each new conductor according to NETA ATS, Ch. 7.3.3. Do not exceed cable manufacturer's recommended maximum test voltage.

4. Perform Partial Discharge test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.

5. Perform Dissipation Factor test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.

D. Medium-voltage cables will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 26 05 13

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SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.

2. Connectors, splices, and terminations rated 600 V and less.

B. Related Sections include the following:

1. Section 26 05 13 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 2001 to 35,000 V.

2. Section 27 15 00 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70 as amended by state and local codes.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. American Insulated Wire Corp.; a Leviton Company.

2. General Cable Corporation.

3. Senator Wire & Cable Company.

4. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70.

D. Multiconductor Cable: Comply with NEMA WC 70.

E. Type AC cable shall have 90 degree C insulation and shall be UL listed as type "ACTHH".

F. Type AC cables shall comply with the following:

1. Where used as the wiring method for branch circuit runs that have been specified elsewhere (or called for on the drawings) as requiring a ground wire, e.g., for electronic equipment and/or for landscape furniture systems, each cable shall incorporate a separate green insulated ground conductor sized equal to the phase conductors.

G. In general, cable ampacities are based on a 60 degree C rating for cables #1 AWG and smaller and on a 75 degree C rating for larger cables. In conjunction with this, note the following:

1. 75 degree C ratings may be utilized for cables #1 AWG and smaller where overcurrent protection and switching devices (OCD's), wiring devices and solidly connected equipment connected to such cables are listed and identified for use with 75 degree C rated conductors. (Note that these specifications require all OCD's - regardless of ampere rating to be suitable for use with 75 degree C rated conductors).

2. Increase indicated cable (and raceway) sizing as required for circuitry where conductors #1 AWG and smaller will connect directly to solidly connected utilization equipment whose load current will exceed the 60 degree C rating of the cable, and for which manufacturer's approval for cable terminations is less than 75 degrees C, or to receptacles whose ampere rating exceeds the 60 degree C rating of the connected cables unless such receptacles are listed for use with 75 degree C rated conductors. Note that accessible intermediate tap boxes may be utilized adjacent to 60 degree C rated terminations to allow conductor "upsizing" locally so as to comply with such termination requirements.

3. Increase indicated cable (and raceway) sizing as required for circuitry where conductors are run in conduits exposed to direct sunlight on or above rooftops in accordance with the temperature adjustment factors described in the electrical code. Conductors shall be Type THHN/THWN.

H. For low voltage systems where circuits are power limited in accordance with Class 2 or Class 3 requirements (as defined in Article 725 of the National Electrical Code) utilize cables having characteristics as follows:

1. Cables shall be of a fluoropolymer type having adequate fire-resistant and low-smoke producing characteristics and shall be U.L. listed for plenum use (Type CL2P for Class 2 circuits, type CL3P or CMP for Class 3 circuits), except that where run in conduit, they may be U.L. type CL3, or where run in cable trays they may be U.L. type CMP.

I. For low voltage systems whose circuits are not power limited Class 2 or Class 3 (in accordance with the requirements of Article 725 of the National Electrical Code), and that are not telecommunications circuitry (in accordance with Article 800 thereof), utilize copper conductors having TFN insulation for sizes #16 AWG and smaller, and type THHN or THWN for sizes #14 AWG and larger. Wires shall be run in electric metallic tubing.

J. For low voltage circuits intended for the distribution of voice or data utilize communications cables (complying with requirements of Article 800 of the National Electrical Code) having characteristics as follows:

1. Cables shall be of a fluoropolymer type having adequate fire-resistant and low-smoke producing characteristics and shall be U.L. listed for plenum use (Type CMP), except that where run in conduit, they may be U.L. type CM.

2.2 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.

2. Hubbell Power Systems, Inc.

3. O-Z/Gedney; EGS Electrical Group LLC.

4. 3M; Electrical Products Division.

5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper for all feeders. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway or Metal-clad cable, Type MC.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits: Type THHN-THWN, single conductors in raceway or Armored cable, Type AC or Metal-clad cable, Type MC.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway or Armored cable, Type AC or Metal-clad cable, Type MC or Nonmetallic-sheathed cable, Type NM.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

I. Class 1 Control Circuits: Type THHN-THWN, in raceway.

J. Class 2 Control Circuits: Type THHN-THWN, in raceway or Power-limited cable, concealed in building finishes.

K. Where required by code, or where indicated on the drawings, feeders and circuitry shall be a fire rated cable system. Mineral-insulated, metal-sheathed cable, Type MI or 2 hour rated MC power cable.

L. Provide THHW-2, THWN-2 insulation for conductors 1/0 and larger in "wet" locations. Conductors utilized in underground installations shall be UL Listed for use in wet locations. Type THHW-2 shall not be utilized where excluded by conduit sizing. Type THWN shall not be utilized for connection to 100 percent rated overcurrent devices.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

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

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

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

E. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Maintain all splices and joints in removable cover boxes or cabinets where they may be easily inspected.

D. Locate each completed conductor splice or joint in the outlet box, junction box, or pull box containing it, so that it is accessible from the removable cover side of the box.

E. Join solid conductors #8 AWG and smaller by securely twisting them together and soldering, or by using insulated coiled steel spring "wire nut" type connectors. Exclude "wire nuts" employing non-expandable springs. Exclude push-on type connectors. Terminate conductors #8 AWG and smaller by means of a neat and fast holding application of the conductors directly to the binding screws or terminals of the equipment or devices to be connected. Terminals and connectors shall be U.L. approved specifically for the application.

F. Join, tap and terminate stranded conductors #6 AWG and larger by means of solder sleeves, taps and lugs with applied solder or by means of pressure indent type connectors, or mechanical connectors utilizing ball tipped set screws. Apply pressure indent type connectors, utilizing tools manufactured specifically for the purpose and having features preventing their release until the full pressure has been exerted on the lug or connector. Factory installed equipment or device terminals shall be of types UL approved specifically for the application.

G. Except where wire nuts are used, build up insulation over conductor joints to a value equal both in thickness and dielectric strength to that of the factory applied conductor insulation. Insulation of conductor taps and joints shall be by means of half-lapped layers of rubber tape, with an outer layer of friction tape; by means of half-lapped layers of approved plastic electric insulating tape; or by means of split insulating casings manufactured specifically to insulate the particular connector and conductor, and fastened with stainless steel or non-metallic snaps or clips.

H. Exclude splicing procedures for neutral conductors in lighting and appliance branch circuitry which utilize device terminals as the splicing points.

I. Exclude joints or terminations utilizing solder in any conductors used for grounding or bonding purposes.

J. Exclude all but solder or pressure indent type joints in conductors used for signaling or communications purposes.

K. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "Penetration Firestopping."

3.7 INSTALLATION OF CIRCUITRY FOR MISCELLANEOUS LOW VOLTAGE SYSTEMS:

A. Comply with requirements described in applicable subsections of this Section. In particular, note the following circuitry requirements for low voltage systems:

1. Wiring for miscellaneous low voltage systems may be run without conduit - subject to the approval of the local authorities - except where prohibited by other sections of these specifications or by indications on the drawings.

2. Where conduit is required, it shall be steel electric metallic tubing (EMT), except that it shall be galvanized intermediate steel conduit where located within 8 feet (2.4 m) of the floor in mechanical spaces (or is otherwise exposed to mechanical damage), or is intended for embedment in concrete.

3. Wires and cables shall have characteristics - in compliance with Articles 725 and/or 800 (as applicable) of the National Electrical Code - as described elsewhere in the specifications or drawings for this project, and shall be U.L. listed in accordance therewith.

4. Where wires and cables are permitted to be run without conduit, they shall be independently supported from the building structure or ceiling suspension systems at intervals not exceeding four feet on center, utilizing cable supports specifically approved for the purpose. Wires and cables shall not rest on or depend on support from suspended ceiling media (tiles, lath, plaster, as well as splines, runners or bars in the plane of the ceiling), nor shall they be supported from pipes, ducts or conduits. Where cables are bundled together, separate bundles shall be provided separately for each type of cabling and separately for each independent system. Bundling and/or supporting ties shall be of a type suitable for use in a ceiling air handling plenum regardless of whether or not installed in a plenum.

5. Cables shall be tagged or labeled at each termination point and in each intermediate junction box, pull box or cabinet through that they pass.

6. Comply with applicable requirements for locating and routing circuitry, for installing circuitry, and for fire-stopping as described in other sub-section of this Section.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 2 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.

b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

4. Where tests are specified to be performed by an independent testing agency, prepare systems, equipment, and components for tests and inspections, and perform preliminary tests to ensure that systems, equipment, and components are ready for independent agency testing. Include the following minimum preparations as appropriate.

    a. Perform insulation-resistance tests.

    b. Perform continuity tests.

    c. Perform rotation test (for motors to be tested).

    d. Provide a stable source of single-phase, 208/120-V electrical power for test instrumentation at each test location.

D. Test Reports: Prepare a written report to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 19

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SECTION 26 05 23 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. UTP cabling.
2. RS-485 cabling.
3. Low-voltage control cabling.
4. Control-circuit conductors.
5. Identification products.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

D. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PERFORMANCE REQUIREMENTS

A. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262 by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inches (1520 mm) or less.

2. Peak Optical Smoke Density: 0.5 or less.

3. Average Optical Smoke Density: 0.15 or less.

B. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

C. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

2.3 BACKBOARDS

A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels in Section 06 10 00 "Rough Carpentry."

2.4 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ADC.

2. Alpha Wire Company; a division of Belden Inc.

3. Belden Inc.

4. CommScope, Inc.

5. Draka Cableteq USA.

6. Genesis Cable Products; Honeywell International, Inc.

7. Mohawk; a division of Belden Inc.

8. Nexans; Berk-Tek Products.

9. Siemon Company (The).

10. Superior Essex Inc.

11. SYSTIMAX Solutions; a CommScope, Inc. brand.

12. 3M.

13. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: 100-ohm, four-pair UTP.

1. Comply with ICEA S-90-661 for mechanical properties of Category 5e cables.

2. Comply with ICEA S-102-700 for mechanical properties of Category 6 cables.

3. Comply with TIA-568-C.1 for performance specifications.

4. Comply with TIA-568-C.2, Category 5e.

5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with NFPA 70 for the following types:

a. Communications, Plenum Rated: Type CMP complying with UL 1685.

b. Communications, Riser Rated: Type CMR complying with UL 1666 and ICEA S-103-701.

c. Communications, General Purpose: Type CM or Type CMG.

2.5 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.

2. PVC insulation.

3. Unshielded.

4. PVC jacket.

5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.

2. Fluorinated ethylene propylene insulation.

3. Unshielded.

4. Fluorinated ethylene propylene jacket.

5. Flame Resistance: NFPA 262.

2.6 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. Multi-pair, twisted, No. 18 AWG (minimum), stranded (19x30) tinned-copper conductors.

2. PVC insulation.

3. Unshielded.

4. PVC jacket.

5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. Multi-pair, twisted, No. 18 AWG (minimum), stranded (19x30) tinned-copper conductors.

2. PVC insulation.

3. Unshielded.

4. PVC jacket.

5. Flame Resistance: Comply with NFPA 262.

2.7 CONTROL-CIRCUIT CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Encore Wire Corporation.

2. General Cable Technologies Corporation.

3. Southwire Company.

B. Class 1 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, complying with UL 44 or UL 83.

C. Class 2 Control Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway, in raceway, complying with UL 44 or UL 83.

D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN-2-THWN-2, in raceway or Type XHHW-2, in raceway, complying with UL 44 or UL 83.

E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

1. Smoke control signaling and control circuits.

2.8 SOURCE QUALITY CONTROL

A. Factory test UTP cables according to TIA-568-C.2.

B. Cable will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2. Flexible metal conduit shall not be used.

B. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.

2. Secure conduits to backboard if entering the room from overhead.

3. Extend conduits 3 inches (75 mm) above finished floor.

4. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1 and NFPA 70, as amended by state and local codes.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.

2. Terminate all conductors; no cable shall contain unterminated elements.

3. Cables may not be spliced.

4. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.

6. 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.

7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.

8. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."

9. Support: Do not allow cables to lay on removable ceiling tiles.

10. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

C. UTP Cable Installation:

1. Comply with TIA-568-C.2.

2. Do not untwist UTP cables more than 1/2 inch (12 mm) at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in mechanical and electrical spaces with terminating hardware and interconnection equipment.

2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 30 inches (760 mm) apart.

3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.

2. Install cabling after the flooring system has been installed in raised floor areas.

3. Below each feed point, neatly coil a minimum of 72 inches (1830 mm) of cable in a coil not less than 12 inches (305 mm) in diameter.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded cable from potential EMI sources including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).

b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches (305 mm).

c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches (600 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).

b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).

c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches (305 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.

b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).

c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches (1200 mm).

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.3 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.

2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.

3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.4 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.5 GROUNDING

A. For data communication wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control wiring and cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.6 IDENTIFICATION

A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-A; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Visually inspect UTP and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors.

B. Prepare test and inspection reports.

END OF SECTION 26 05 23

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SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes grounding systems and equipment, plus the following special applications:
   1. Underground distribution grounding.
   2. Ground bonding common with lightning protection system.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
   1. Test wells.
   2. Ground rods.
   3. Ground rings.
   4. Ground plates.
   5. Grounding arrangements and connections for separately derived systems.
   6. Grounding for sensitive electronic equipment.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 467 for grounding and bonding materials and equipment.

D. Comply with NFPA 70, as amended by state and local codes.

E. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

F. Comply with applicable BICSI standards.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. For insulated conductors, comply with Division 26 section Low-Voltage Electrical Power Conductors and Cables".

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

E. Grounding Electrode Conductors: Stranded cable.

F. Bare Copper Conductors:
1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

G. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 by 10 feet (19 by 3000 mm) in diameter.

B. Plate Electrodes: Copper plates, minimum 0.10 inch (3 mm) thick, 24 inch (600 mm) square.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Electrode: Install bare tinned-copper conductor, No. 3/0 AWG minimum.
1. Bury at least 24 inches (600 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
1. Install bus on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

E. Conductor Terminations and Connections:
1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with service equipment by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.3 EQUIPMENT GROUNDING

A. Equipment Grounding Conductor Application: Comply with NFPA 70, as amended by state and local codes, for sizes and quantities of equipment grounding conductors except where specific types, larger sizes, or more conductors are indicated.

B. Install insulated equipment grounding conductors with all feeders and branch circuits.

C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
1. Feeders and branch circuits.
2. Receptacle circuits.
3. Single-phase motor and appliance branch circuits.
4. Three-phase motor and appliance branch circuits.
5. Flexible raceway runs.
6. Armored and metal-clad cable runs.
7. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, or distribution panel to equipment grounding bar terminal on busway.
8. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

D. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

E. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

F. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
   1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, antenna, terminal cabinet, wiring closet, and central equipment location.
   2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch (6.3-by-100-by-300-mm) grounding bus.
   3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

G. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

H. The ground bus of switchgear shall be connected to the main grounding electrode by means of insulated grounding electrode conductors run in intermediate metallic conduit and sized as per Code.

I. The neutral bar of each individually enclosed service switch shall be bonded to its enclosure on the line side of a removable link (included therein), and connected to the main grounding electrode by means of insulated grounding electrode conductors run in intermediate metallic conduit and sized as per Code.

J. The emergency generator system neutral shall be grounded by means of a connection from the neutral bar in the generator main circuit breaker enclosure to the main grounding electrode by means of an insulated grounding electrode conductor run in intermediate conduit and sized as per Code. Include a bonding connection from the neutral to the equipment enclosure.

K. The neutral of secondary winding of each low voltage (i.e., less than 600 volts) transformer shall be grounded to the grounding electrode as specified hereinafter by means of an insulated grounding conductor sized as per Code and run in IMC. The neutral of each transformer shall be bonded to the transformer enclosure by means of an insulated conductor sized as per code. If not factory installed the jumper shall be field installed within the transformer enclosure.

L. The grounding electrode for each low voltage (both windings 600 volts or less) transformer shall consist of an exothermic welded connection to adjacent structural steel at a point where only fireproofing and not structural concrete is applied to it.

M. Bond metallic conduits containing grounding electrode conductors and main bonding conductors to the ground bus service enclosure and/or grounding electrode at both ends of each run utilizing grounding bushings and jumpers. Bonding jumpers shall be sized equal to the grounding electrode conductors.

N. Provide grounding bonds for all metallic conduits of the light and power system that terminate at (or in pits below) distribution equipment for which a ground bus is specified. Accomplish this by equipping the conduits with bushings of the grounding type connected individually to the ground bus.

O. Provide supplementary ground bonding to maintain continuity of the equipment and raceway grounding system as follows:

P. Bonding jumpers shall be applied where wiring devices (receptacles and switches) are not equipped with approved self-grounding features. Include any necessary field modifications for termination of the bonding jumpers so as to ensure grounding continuity.

Q. Bonding jumpers shall be applied to ensure that grounding continuity does not depend solely on the supporting screws fastening metallic enclosures together.

R. Include any necessary field modifications for termination of the bonding jumpers so as to ensure grounding continuity.

S. Provide copper ground bus around perimeter of each room containing equipment operating in excess of 600 volts. Ground bus shall be mounted 18 inches (45 cm) above floor and routed above doors, and shall be installed on insulators. Provide a minimum of two ground connections to the main grounding electrode. Provide a minimum of two ground connections to each piece of equipment within the room. Provide ground connections from ground bus to each metallic object (doorframe, stair, mechanical duct or diffuser, etc.) located within the room. Each grounding connection shall be a 4/0, 600 volt insulated copper conductor.

3.4 INSTALLATION

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

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
   2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.

1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

I. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.
   1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
   2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

   Where specifically noted on the drawings, or described hereinbefore in this Section, include insulated equipment and raceway grounding conductors run within the raceways. Where insulated equipment grounding conductors required for feeders have not been included in the quantities of conductors indicated on the drawings, incorporate such conductors in accordance with the electrical code. Adjust conduit sizing if required.

J. Common Ground Bonding With Lightning Protection System: Bond electric power system ground directly to lightning protection system grounding conductor at closest point to electric service grounding electrode. Use bonding conductor sized same as system ground conductor and installed in conduit.

3.5 LABELING

A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
   1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
   3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal and at ground test wells. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      b. Perform tests by fall-of-potential method according to IEEE 81.
   4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System: 5 ohms.
   2. Manhole Grounds: 10 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

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SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.

2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

2. Nonmetallic slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.

2. Steel slotted channel systems. Include Product Data for components.

3. Nonmetallic slotted channel systems. Include Product Data for components.

4. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70 as amended by State and Local Codes.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 07 72 00 "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Allied Tube & Conduit.

b. Cooper B-Line, Inc.; a division of Cooper Industries.

c. ERICO International Corporation.

d. GS Metals Corp.

e. Thomas & Betts Corporation.

f. Unistrut; Tyco International, Ltd.

g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.

4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. U-Channel Systems: 16-gauge steel channels, with 9/16-inch (14 mm) diameter holes, at a minimum of 8 inches (20 cm) on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Cooper B-Line, Inc.; a division of Cooper Industries.

2) Empire Tool and Manufacturing Co., Inc.

3) Hilti Inc.

4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

5) MKT Fastening, LLC.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

5. Toggle Bolts: All-steel springhead type.

6. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 05 50 00 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps single-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To New Concrete: Bolt to concrete inserts.

2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

3. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.

4. To Light Steel: Sheet metal screws.

5. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

E. Raceway Supports: Comply with the following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.

2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs (90 kg), provide additional strength until there is a minimum of 200 lbs (90 kg) safety allowance in the strength of each support.

3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

4. Support parallel runs of horizontal raceways together on trapeze-type hangers.

5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch (DN 41) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4 inch (6 mm) diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.

6. Support exposed and concealed raceway within 1 foot (30 cm) of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.

7. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on conductor terminals.

F. Vertical Conductor Supports: Install simultaneously with installation of conductors.

G. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

H. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches (60 cm) from the box.

I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.

2. Holes cut to depth of more than 1-1/2 inches (4 cm) in reinforced concrete beams or to depth of more than 3/4 inch (2 cm) in concrete shall not cut the main reinforcing bars. Fill holes that are not used.

3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock- resistant fasteners for attachments to concrete slabs.

J. In general, walls and partitions are not suitable for supporting the weight of panelboards, dry type transformers, and the like. Include supporting frames or racks extending from floor slab to ceiling slab for all such items unless specifically instructed otherwise by the Architect.

K. Include supporting frames or racks for equipment, intended for vertical surface mounting, which is required in a free standing position.

L. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members. They shall be rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of all equipment mounted on them.

M. No work intended for exposed installation in damp locations is mounted directly on any building surface. In such locations, flat bar members or spacers shall be used to create a minimum of 1/4 inch (6 mm) air space between the building surfaces and the work.

N. Nothing (including outlet, pull and junction boxes and fittings) shall depend on electric conduits, raceways or cables for support except that threaded hub type fittings having a gross volume not in excess of 100 cubic inches (1600 cc) may be supported from heavy wall conduit, where the conduit in turn is securely supported from the structure within 5 inches (12 cm) of the fitting on two opposite sides.

O. Nothing shall rest on, or depend for support on, suspended ceiling media (tiles, lath, plaster, as well as splines, runners, bars and the like in the plane of the ceiling). Vertical members that suspend the ceiling (together with their horizontal bracing that occurs above the ceiling), however, may be used for support, subject to the following criteria:

1. Supporting procedures shall be in accordance with the ceiling system manufacturer's instructions.

2. Supporting members for circuitry shall be rigid. Wires may not be used for such supports.

3. The ceiling is not fire rated.

P. In conjunction with lighting fixtures or other items weighing less than 40 pounds (18 kg), the above restriction against supporting from suspended ceiling splines, runners or bars in the plane of the ceiling may be waived for ceilings that have been specifically approved for the weight and arrangement of fixtures being applied. Any support members, mechanical fastening means (i.e., bolts, screws or rivets), or other appurtenances, however, required to tie in or adapt to the fixtures and their ceiling opening frames (if any) to the ceiling in the approved manner shall be included as part of the electric work.

Q. As a minimum procedure, support surface or pendant mounted lighting fixture:

1. From its outlet box by means of an interposed metal strap, where weight is less than 5 pounds (2 kg).

2. From its outlet box by means of a hickey or other direct threaded connection, where weight is from 5 pounds (2 kg) to 50 pounds (20 kg).

3. Directly from structural slab, deck or framing member, where weight exceeds 50 pounds (20 kg).

R. As a minimum procedure, support recessed lighting fixtures as follows:

1. From ceiling suspension members, as described above, where weight is 80 pounds (35 kg) or less. Fluorescent fixtures shall be provided with clips to secure the fixtures to the ceiling members at two opposite ends of each fixture.

2. Directly from structural slabs, decks or framing members where weight is more than 80 pounds (35 kg).

S. Include in the electric work channel sills or skids for leveling and support of all floor mounted electrical equipment.

T. Where permitted loading is exceeded by direct application of electrical equipment to a slab or deck, include in the electric work proper dunnage as required to distribute the weight in a safe manner.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 05 50 00 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. All equipment, including but not limited to loadbank, camlock connector for future portable generator, Substations, Motor control centers, Generators, Automatic transfer switches, transformers shall be provided with foundations.

B. Furnish shop drawings showing adequate concrete reinforcing steel details and templates for all concrete foundations and supports, and all required anchor bolts and other appurtenances necessary for the proper installation of this equipment. All concrete work shall be shown in detail on the shop drawings, prepared by this trade.

C. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

D. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03 30 00 "Cast-in-Place Concrete." and Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."

E. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 GROUT

A. Install nonmetallic nonshrink grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions.

B. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

C. Clean surfaces that will come into contact with grout.

D. Provide forms for placement of grout, as required.

E. Avoid air entrapment when placing grout.

F. Place grout to completely fill equipment bases.

G. Place grout on concrete bases to provide a smooth bearing surface for equipment.

H. Place grout around anchors.

I. Cure placed grout according to manufacturer's printed instructions.

3.6 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

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SECTION 26 05 31 - HEAT TRACING FOR PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes piping heat tracing for freeze prevention, with self-regulating parallel resistance cables.

B. Series resistance.

C. Cables shall be UL Listed, CSA Certified System of including components and controls.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Chromalox, Inc.

B. Delta-Therm Corp.

C. Pyrotenax; Pentair Thermal.

D. Raychem; Pentair Thermal.

2.2 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Comply with IEEE 515.1.

B. Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. The heating cable shall be covered by a radiation-crosslinked modified polyolefin dielectric jacket. The heating cable shall have a braid of tinned copper for ground path and an outer jacket-of fluoropolymer as required by NEC. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

C. Electrical Insulating Jacket: Flame-retardant polyolefin.

D. Cable Cover: Tinned-copper Stainless-steel braid and polyolefin outer jacket with ultraviolet inhibitor.

E. Maximum Operating Temperature (Power On): 150 deg F (65 deg C).

F. Maximum Exposure Temperature (Power Off): 185 deg F (85 deg C).

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Capacities and Characteristics:

1. Maximum Heat Output: 8 W/ft. (26 W/m) as required per the table below.

B=8W/FT Cable Insulation Thickness (inches)	Pipe Size (IPS)	Minimum Ambient Temperature (°F)			
		20°	10°	0°	-20°
		Metal (Plastic)	Metal (Plastic)	Metal (Plastic)	Metal (Plastic)
0.5	½-1	A	A	A	A
	1-1/4	A	A	A	A

B=8W/FT Cable Insulation Thickness (inches)	Pipe Size (IPS)	Minimum Ambient Temperature (°F)			
		20°	10°	0°	-20°
		Metal (Plastic)	Metal (Plastic)	Metal (Plastic)	Metal (Plastic)
	1-1/2	A	A	A	A
	2	A	A	A	B
	2-1/2	A	A	A	B
	3	A	A	B	2A
	4	A	A	B	2A
	6	A	B	2A	2B
1.0	½-2	A	A	A	A
	2-1/2	A	A	A	A
	3	A	A	A	A
	4	A	A	A	B
	6	A	A	B	B
	8	A	A	B	2A
	10	A	B	2A	2B
1.5	½-3	A	A	A	A
	4	A	A	A	A
	6	A	A	A	B
	8	A	A	A	B
	10	A	A	B	B
2.0	½-4	A	A	A	A
	6	A	A	A	A
	8	A	A	A	B
	10	A	A	A	B

2. Piping Diameter: <Insert NPS (DN)>.
3. Number of Parallel Cables: 2
4. Electrical Characteristics for Single-Circuit Connection:

    a. Volts: 277.
    b. Minimum Circuit Ampacity: 20 Amperes.
    c. Maximum Overcurrent Protection: 30 Amperes.

2.3 SERIES-RESISTANCE HEATING CABLES

A. Comply with UL 1673.

B. Heating Element: Single- or dual-conductor resistor wire. Terminate with waterproof, factory-assembled, nonheating leads with connectors at both ends.

C. Electrical Insulating Mineral: Magnesium oxide.

D. Cable Cover: Copper-nickel alloy and high-density polyethylene outer jacket.

E. Maximum Operating Temperature: 300 deg F (150 deg C).

F. Capacities and Characteristics:

1. Maximum Heat Output: 8 W/ft. (24.6 W/m).
2. Spacing: as recommended by manufacturer
3. Electrical Characteristics for Single-Circuit Connection:

    a. Volts: 277.
    b. Phase: 1.
    c. Hertz: 60.
    d. Minimum Circuit Ampacity: 30A
    e. Maximum Overcurrent Protection: 30A.

2.4 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F (minus 1 to plus 10 deg C).
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

B. Precipitation and Temperature Sensor for Snow Melting on Roofs and in Gutters:

1. Microprocessor-based control with manual on, automatic, and standby/reset switch.
2. Precipitation and temperature sensors shall sense the surface conditions of roof and gutters and shall be programmed to energize the cable as follows:

    a. Temperature Span: 34 to 44 deg F (1 to 7 deg C).
    b. Adjustable Delay-Off Span: 30 to 90 minutes.
    c. Energize Cables: Following two minute delay if ambient temperature is below set point and precipitation is detected.
    d. De-Energize Cables: On detection of a dry surface plus time delay.

3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
4. Minimum 30-A contactor to energize cable or close other contactors.
5. Precipitation sensor shall be freestanding.
6. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

2.5 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils (0.08 mm) thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): 3/4 inch (19 mm) minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches (150 mm) or Larger: 1-1/2 inches (38 mm) minimum.

C. For each heat tracing circuit shown on the contract drawings furnish one separate digitrace (910: 1WL*EMR2 Part # 10170-001) single point heat trace controller manufactured by “Tyco” or approved equal. The controller shall have isolated solid state triac relay, dry contact and RS-485 communication interface suitable for central programming, status review and alarm annunciation to building BMS System. The controller shall be housed in NEMA 4x enclosure, surface mounted on wall, or column, minimum 8’-0” AFF. RTD sensor shall be type C1D1RDT Cat # BTD7AL.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Install the following types of electric heating cable for the applications described:

1. Snow and Ice Melting on Roofs and in Gutters and Downspouts: Self-regulating, parallel-resistance heating cable. Coordinate exact location and routing with architect.
2. Temperature Maintenance for Domestic Hot Water: Self-regulating, parallel-resistance heating cable.

3. Specify where MI cables are to be used.

3.3 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Snow and Ice Melting on Roofs and in Gutters and Downspouts: Install on roof and in gutters and downspouts with clips furnished by manufacturer that are compatible with roof, gutters, and downspouts.

C. Electric Heating-Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install electric heating cables according to IEEE 515.1.
3. Install warning tape on piping insulation where piping is equipped with electric heating cables.

D. Set field-adjustable switches and circuit-breaker trip ranges.

E. Install heater strip as a single run (or multiple parallel runs where cable footage so requires) along water piping before insulation is applied to same.

F. Fasten heater strip to piping with glass adhesive tape (Raychem Cat. No. “GT-66”) applied at intervals not exceeding 1” on centers and in all cases as required to maintain the heater strip in continuous contact with the metal of the water piping.

G. Do not connect the bus wires together; XL-Trace is a parallel circuited heater strip.

H. Furnish and install on the outlet box from which the heater is supplied, a 120 volt, 22 amp, single pole, double throw, 25-225°F, ambient type thermostat (Raychem Cat No. “AMC-1A”) in NEMA type 4 watertight enclosure.

I. Connect incoming circuit through thermostat to heater strip.

J. Provide circuit breaker equipped with 30 mA ground-fault equipment protection device (GFEP) for each incoming power circuit.

K. Utilize ½” flexible metallic conduit to protect wire between thermostat and point where it connects to heater strip.

3.4 CONNECTIONS

A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

C. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

D. Cables will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION 26 05 31

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SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Metal wireways and auxiliary gutters.
3. Surface raceways.
4. Boxes, enclosures, and cabinets.
5. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Section 27 05 28 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
3. Section 28 05 28 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. EMT: Electrical metallic tubing.

C. GRC: Galvanized rigid steel conduit.

D. IMC: Intermediate metal conduit.

E. RTRC: Reinforced thermosetting resin conduit.

1.4 ACTION SUBMITTALS

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

B. LEED Submittals:

1. Product Data: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.

2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.

2. Allied Tube & Conduit; a Tyco International Ltd. Co.

3. Anamet Electrical, Inc. (Flexible metallic conduits only)

4. Electri-Flex Company. (Flexible metallic conduits only)

5. O-Z/Gedney; a brand of EGS Electrical Group.

6. Picoma Industries, a subsidiary of Zekelman Industries.

7. Republic Conduit.

8. Robroy Industries.

9. Southwire Company.

10. Thomas & Betts Corporation.

11. Western Tube and Conduit Corporation.

12. Wheatland Tube Company; a division of John Maneely Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit or IMC.

1. Comply with NEMA RN 1.

2. Coating Thickness: 0.040 inch (1 mm), minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. FMC: Comply with UL 1; zinc-coated steel.

I. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

J. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Fittings for EMT:

a. Material: die cast.

b. Type: compression.

2. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

K. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper B-Line, Inc.

2. Hoffman; a Pentair company.

3. Mono-Systems, Inc.

4. Square D; a brand of Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, Type 3R, or Type 4 as applicable, unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.3 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Mono-Systems, Inc.

b. Panduit Corp.

c. Wiremold / Legrand.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Adalet.

2. Cooper Technologies Company; Cooper Crouse-Hinds.

3. EGS/Appleton Electric.

4. Erickson Electrical Equipment Company.
5. FSR Inc.
6. Hoffman; a Pentair company.
7. Hubbell Incorporated; Killark Division.
8. Kraloy.
9. Milbank Manufacturing Co.
10. Mono-Systems, Inc.
11. O-Z/Gedney; a brand of EGS Electrical Group.
12. RACO; a Hubbell Company.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
16. Thomas & Betts Corporation.
17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy except us aluminum with ARC, Type FD, with gasketed cover.

E. Metal Floor Boxes:

1. Material: Cast metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron except use cast aluminum with ARC, with gasketed cover.

I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep) or 4 inches by 2-1/8 inches by 2-1/8 inches deep (100 mm by 60 mm by 60 mm deep) or deeper as required to accommodate wiring devices.

K. Gangable boxes are prohibited.

L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, or Type 4 as applicable with continuous-hinge cover with flush latch unless otherwise indicated.

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

2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

M. Cabinets:

1. NEMA 250, Type 1 or Type 3R as applicable galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.

3. Key latch to match panelboards.

4. Metal barriers to separate wiring of different systems and voltage.

5. Accessory feet where required for freestanding equipment.

6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC or IMC.

2. Concealed Conduit, Aboveground: GRC or IMC.

3. Exposed within 30 feet (10 meters) cooling tower: PVC coated steel conduit.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed in dry location and not Subject to Physical Damage: EMT.

2. Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following up to 8'-0" above finished floor:

a. Indoors where subject to moist.

b. .Wiring over 600 volts

c. Mechanical rooms.

3. Concealed in Ceilings and Interior Walls and Partitions: EMT.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): Flexible steel, except use liquid-Tial flexible conduit in damp or wet locations.

5. Damp or Wet Locations: GRC.

6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.

2. EMT: Use compression, cast-metal fittings. Comply with NEMA FB 2.10.

3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface raceways only where indicated on Drawings.

1. The following shall be treated as damp or wet locations within building confines, regardless of whether or not a high ambient moisture level is found to exist:

a. Spaces where any designations indicating weatherproof (WP) or vaporproof (VP) appear on the drawings.

b. Parking garage areas where open to exterior.

c. Cooling tower areas.

d. Below waterproofing in slabs applied directly on grade.

e. Kitchens up to a height of 18inches (45 cm) above finished floor.

f. Outside of waterproofing in foundation walls in contact with grade.

g. Above waterproofing in slabs having no building above.

h. Above waterproofing in fill on slabs having no building above.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Install temporary closures to prevent foreign matter from entering raceway.

F. Protect stub-ups from damage where conduits rise through floor slabs. Arrange stub-ups so curved portions of bends are not visible above finished slab.

G. Install no more than the equivalent of four 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

H. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much possible.

1. Run parallel or banked raceways together on common supports.

2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

I. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Use insulating bushings to protect conductors.

J. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches (300 mm)of enclosures to which attached.

L. Raceways Embedded in Slabs:

1. Embedment of circuitry in field poured concrete slabs and fill will be permitted subject to the approval of the structural engineer, compliance with the "pour schedule" established for the project, and to the following criteria:

2. They shall be routed in such a manner as to coordinate with the structural requirements of the building. Submit proposed routing to structural engineer for approval. Raceways proposed to be embedded in concrete which are not approved by the structural engineer shall be installed in another manner (in accordance with these specifications).

3. Maximum outside diameter of raceways shall not exceed one third of concrete thickness. Raceways shall be run in a "single layer" with their outside surface no closer than 1 inch (25mm) to any surface of the concrete.

4. Install in middle 1/3 of slab thickness.

5. Provide support for raceways independent of reinforcing rods.

6. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.

7. Space raceways laterally to prevent voids in the concrete.

8. Run raceway larger than 1 inch (DN 27) trade size parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place raceway close to slab support.

9. They shall not be spaced closer than 3 diameters on center, with a minimum of 3 inches (75mm) between the outside surfaces of the raceways, except at tees, crosses or other single level wide angle junction points.

10. Where crossovers or close groupings are unavoidable, circuitry shall either be dog-legged out of the concrete or be carefully field coordinated so as not to cause structural weakness. Where in metal deck or subfloor type of construction, crossovers shall occur only in valleys.

11. Where turned up or down into a wall or partition they shall, before entering same, be routed parallel for a long enough distance to assure that no relocation of the wall or partition will be necessary to conceal the required bend.

12. They shall be routed in accordance with field instructions issued by the Architect where such instructions differ from specifications set forth herein.

M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

N. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

O. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

Q. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install the locknuts with dished part against the box. Install locknuts hand tight plus 1/4 turn more.

R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

S. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

U. Telephone and Signal System Raceways 2-Inch Trade Size (DN 53) and Smaller: In addition to the above requirements, install in maximum lengths of 100 feet (30 m) and with a maximum of two 90-degree bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements. Pull or junction boxes shall be sized in accordance with ANSI/EIA/TIA-569A guidelines. Pull boxes shall be placed in a straight section of conduit, for raceways over 2 inch size, bending radius shall be not less than 10 times the internal raceway diameter. For fiber optic cable, raceway bending radius shall be not less than 10 times the internal conduit diameter.

V. Surface Raceways:

1. Install surface raceway with a minimum 2-inch (50-mm)radius control at bend points.

2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

W. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

X. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Where an underground service raceway enters a building or structure.

3. Where otherwise required by NFPA 70.

Y. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

Z. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.

   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.

   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.

4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

AA. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations.

2. Install separate ground conductor across flexible connections.

3.3 INSTALLING JUNCTION, PULL AND OUTLET BOXES:

A. Apply junction and pull boxes in accordance with the following:-

1. Include pull boxes in long straight runs of raceway to assure that cables are not damaged when they are pulled in.

2. Include junction and pull boxes to assure a neat and workmanlike installation of raceways.

3. Include junction and pull boxes to fulfill requirements pertaining to the limitations to the number of bends permitted in raceway between cable access points, the accessibility of cable joints and splices, and the application of cable supports.

4. Where the wires and cables following the same routing are indicated as running through separate pull boxes, it shall be understood that a segregation of the wires and cables is required. Separately indicated pull boxes may be incorporated into single boxes on condition that segregation is maintained by barriers of the type hereinafter specified.

5. Include all required junction and pull boxes regardless of indications on the drawings (which, due to symbolic methods of notation, may omit to show some of them).

B. Apply outlet boxes in accordance with the following:-

1. Unless noted below or otherwise specifically indicated, include a separate outlet box for each individual wiring device, lighting fixture and signal or communication system outlet component. Outlet boxes supplied attached to lighting fixtures shall not be used as replacements for the boxes specified herein unless they are specifically rated to accept "through circuit" building wires.

2. A continuous row of fixtures of the end-to-end channel type, designed for "through wiring," and wired in accordance with the specifications hereinafter pertaining to circuitry through a series of lighting fixtures, may be supplied through a single outlet box.

3. A series of separate fixtures, designed for "through wiring," spaced not more than 2 feet (600mm) apart, and interconnected with conduit or raceway and circuitry which is in accordance with the specifications hereinafter pertaining to circuitry through a series of lighting fixtures, may be supplied through a single outlet box.

4. Connection to recessed ceiling fixtures supplied with pigtails may be arranged so that more than one, but not more than four, such fixtures are connected into a single outlet box. When adopting this procedure:-

    a. Utilize an outlet box no smaller than 4-11/16 inches (119mm) square by 2-1/8 inches (54 mm) deep.

    b. Allow no fixture to be supplied from an outlet box in another room.

5. Multiple local switches indicated at a single location shall be gang mounted in a single outlet box.

6. Include all required outlet boxes regardless of indications on the drawings (which due to symbolic methods of notation, may omit to show some of them).

7. Regardless of any indications on the drawings, flush wall mounted outlet boxes shall not be set back-to-back in fire rated walls or partitions, even if they are displaced vertically. Such outlets shall be offset horizontally by 24 inches (610mm) or as otherwise required to maintain the fire rating.

8. Exclude "through-the-wall" collar type outlet boxes for flush devices indicated back-to-back in non-fire rated partitions or walls. Where necessary to accommodate box depths, outlets shown back-to-back shall be horizontally offset.

C. Install junction boxes, pull boxes and outlet boxes in accordance with the following:-

1. Exclude surface mounted outlet boxes in conjunction with concealed circuitry.

2. Exclude unused circuitry openings in junction and pull boxes. In larger boxes each such opening shall be closed with a galvanized sheet steel plate fastened with a continuous weld all around. In small outlet type boxes, utilize plugs as specified for such boxes.

3. Close up all unused circuitry openings in outlet boxes. Unused openings in cast boxes shall be closed with approved cast metal threaded plugs. Unused openings in sheet metal boxes shall be closed with sheet metal knock-out plugs.

4. Pack "through the wall" collar type outlet boxes with a sound deadening, non-hardening, non-hygroscopic, non- combustible, high dielectric stuffing material manufactured specifically for the purpose.

5. Equip outlet boxes used in circuitry operating in the range of 250 to 300 volts to neutral with barriers to separate wiring devices connected to different phase legs.

6. Outlet boxes for switches shall be located at the strike side of doors. Indicated door swings are subject to field change. Outlet boxes shall be located on the basis of final door swing arrangements.

7. Boxes and plaster covers for duplex receptacles shall be arranged for vertical mounting of the receptacle.

8. Equip outlet boxes used for devices which are connected to wires of systems supplied by more than one set of voltage characteristics with barriers to separate the different systems.

D. Barriers in junction and pull boxes of outlet size shall be of the same metal as the box.

E. Barriers in junction and pull boxes which are larger than outlet size shall be of polyester resin fiberglass of adequate thickness for mechanical strength but in no case less than 1/4 inch (6.5mm). Each barrier shall be mounted, without fastenings, between angle iron guides so that they may be readily removed.

3.4 MOUNTING HEIGHTS:

A. Heights of all wall mounted outlets and equipment shall be in accordance with the following list. (Dimensions are above finished floor unless noted.)

1. Receptacle or telephone outlet in field constructed wall, partition or column unless otherwise specified below -- 18 inches (45 cm) to centerline.

2. Receptacle or telephone outlet in mechanical spaces, electric switchboard rooms, electric closets -- 60 inches (150 cm) to centerline.

3. Toggle switch outlet in field constructed wall partition or column -- 46 inches (117 cm) to centerline.

4. Wall mounted occupancy switch 0 46 inches to centerline.

5. Bracket lighting outlets, except for "over door" -- 90 inches (228 cm) to centerline.

6. Bracket lighting outlet over door -- as required to center outlet between top surface of door lintel and underside of ceiling.

7. Wall exit sign except for over door -- 90 inches (228 cm) to centerline.

8. Exit sign over door -- As required to center sign between top surface of door lintel and underside of ceiling.

9. Outlet for any signal system device other than fire alarm station requiring manual operation -- 48 inches (122 cm) to centerline.

10. Manual fire alarm station -- 48 inches (122 cm) to centerline.

11. Outlet for any signal system visual or sounding device other than fire alarm visual device or visual/sounding device -- As required for device to clear underside of ceiling by 1 inch (25 mm).

12. Outlet for fire alarm visual device -- Visual device 80 inches (203 cm) AFF to device bottom, except as otherwise noted.

B. Architectural drawings and field instructions issued by the Architect take precedence over the above list and shall be adhered to.

C. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

D. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

E. Locate boxes so that cover or plate will not span different building finishes.

F. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

G. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

H. Set metal floor boxes level and flush with finished floor surface.

3.5 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.

2. Install backfill as specified in Section 31 20 00 "Earth Moving."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 20 00 "Earth Moving."

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.

b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.

7. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

3.6 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes with bottom below frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.9 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

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SECTION 26 05 43 - UNDERGROUND DUCTS AND UTILITY STRUCTURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section includes the following basic electrical materials and methods to complement other Division 26 Sections.

B. This Section includes underground conduits and ducts, duct banks, pull boxes and other underground utility structures.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

1.3 DEFINITIONS

A. PVC: Rigid Polyvinyl Chloride Conduit

B. RTRC: Reinforced Thermosetting Resin Conduit

1.4 SYSTEM DESCRIPTION

A. Underground Ducts: Plastic conduit encased in concrete.

1.5 SUBMITTALS

A. Product Data: For conduit and duct, duct bank materials, and miscellaneous components.

B. Shop Drawings: Show details and design calculations for precast manholes and handholes, including reinforcing steel. Stamp drawings with seal of registered professional structural engineer.

C. Certificate for concrete and steel used in underground precast concrete utility structures, according to ASTM C 858.

D. Product Test Reports: Indicate compliance with ASTM C857 and ASTM C858.

E. Record Documents: Show dimensioned locations of underground ducts, handholes, and manholes.

1.6 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this Section that are Underwriters Laboratories listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.

B. Comply with NFPA 70.

C. Comply with ANSI C2.

D. RTRC: Comply with UL 1684A and NEMA TC14

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, manholes, and handholes with final arrangement of other utilities as determined in the field.

B. Coordinate elevations of duct and duct-bank entrances into manholes and handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations as required to suit field conditions and to ensure duct runs drain to manholes and handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.1 CONDUIT AND DUCT

A. Rigid Plastic Underground Conduit: UL 651A, Type EB PVC.

B. RTRC.

C. Rigid Plastic Conduit: NEMA TC 2, Schedule 40 or Schedule 80 PVC, rated for use with 90 deg C conductors under all installation conditions.

D. Rigid Steel Conduit: ANSI C80.1, galvanized.

E. Plastic-Coated Rigid Steel Conduit and Fittings: NEMA RN 1.

F. PVC Conduit Fittings: NEMA TC 3.

G. Manufactured Bends: Not less than 36-inch (900 mm.) radius.

2.2 ACCESSORIES

A. Duct Supports: Rigid PVC spacers selected to provide minimum duct spacings and concrete cover depths indicated, while supporting ducts during concreting.

2.3 CONSTRUCTION MATERIALS

A. Concrete: Conform to Division 26 Section "Common Work Results for Electrical " for concrete and reinforcing.

1. Strength: 3,000 psi (20.7 MPa) minimum 28-day compressive strength.

2. Aggregate For Duct Encasement: 3/8-inch (10 mm) maximum size.

PART 3 - EXECUTION

3.1 APPLICATION

A. Underground Duct Banks: Concrete encased rigid plastic underground conduit, except as noted below.

B. Duct Banks Under Paved Areas Open To Regular Vehicular Traffic: Reinforced concrete encased rigid plastic underground conduit.

C. Duct Banks Passing Under Buildings: Concrete encased rigid steel conduit.

D. Manholes (and Handholes): Cast-in-place concrete or underground precast concrete utility structures.

3.2 EXAMINATION

A. Examine site to receive ducts for compliance with installation tolerances and other conditions affecting performance of the underground ducts. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 EARTHWORK

A. Excavation and Backfill: Conform to Division 26, Section "Common Work Results for Electrical."

B. Restore surface features at areas disturbed by excavation, and reestablish original grades except as otherwise indicated. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work.

C. Restore disturbed paving. Refer to "Cutting and Patching" in Division 01.

3.4 CONDUIT AND DUCT INSTALLATION

A. Install nonmetallic conduit and duct as indicated according to manufacturer's written instructions.

B. Slope: Pitch ducts minimum of 4 inches per 100 feet (1:300) to drain toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between 2 manholes to drain in both directions.

C. Curves and Bends: Use manufactured elbows for stub-ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of 25 feet (7.5 m) both horizontally and vertically at other locations.

D. Make joints in ducts and fittings watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

E. Duct Entrances to Manholes: Space end bells approximately 10 inches (250 mm) on center for 5-inch (125 mm) ducts and varied proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances.

F. Building Entrances: Transition from underground duct to conduit 10 feet (3 m) minimum outside the building wall. Use fittings manufactured for the purpose. Follow appropriate installation instructions below.

1. Concrete-Encased Ducts: Install reinforcing in duct banks passing through disturbed earth near buildings and other excavations. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.

2. Waterproofed Wall and Floor Entrances: Install a watertight entrance-sealing device with the sealing gland assembly on the inside. Anchor device into masonry construction with 1 or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

G. Concrete-Encased Nonmetallic Ducts: Support on plastic separators coordinated with duct size and required duct spacing, and install according to the following:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, and secure separators to the earth and to ducts to prevent floating during concreting. Do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not use power-driven agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between manholes or other terminations in 1 continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (18 mm) reinforcing rod dowels extending 18 inches (450 mm) into the concrete on both sides of joint near the corners of the envelope.

3. Reinforcing: Reinforce duct banks where they cross disturbed earth, where they cross over or under underground utilities or other obstructions and where indicated.

4. Forms: Use the walls of the trench to form the side walls of the duct bank where the soil is self-supporting and concrete envelope can be poured without soil inclusions, otherwise, use forms.

5. Minimum Clearances Between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.

6. Depth: Except as otherwise indicated, install top of duct bank at least 30 inches (750 mm) below finished grade. Increase cover where required by field conditions. Clearance may be reduced (to a minimum of 18" (450 mm)) where passing over other utilities or obstructions or where necessary to avoid low points. Reinforce the concrete where clearance is so reduced.

H. Stub-Ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete pads, extend steel conduit a minimum of 5 feet (1.5 m) from edge of pad. Install insulated grounding bushings on the terminations. Couple steel conduits to the ducts with adapters designed for the purpose and then encase coupling with 3 inches (75 mm) of concrete.

I. Sealing: Provide temporary closure at terminations of ducts that are wired under this Project. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 psi (1.03 MPa) hydrostatic pressure.

J. Pulling Cord: Install 100-pound (45 kg) test nylon cord in ducts, including spares.

3.5 EXCAVATION FOR UNDERGROUND CONDUIT BANKS

A. Slope sides of excavations to comply with local codes and ordinances. Shore and brace as required for stability of excavation.

B. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches (750 mm) below finished grade elevation.

C. Install sediment and erosion control measures in accordance with local codes and ordinances.

D. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.

2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

E. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.

2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

F. Trenching: Excavate trenches for electrical installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches (150 to 225 mm) clearance on both sides of raceways and equipment.
2. Excavate trenches to depth required to accommodate the installation of conduit (duct banks) in compliance with the requirements of Section 26 05 43.
3. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.
4. 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 (150 mm) of stone or gravel cushion between rock bearing surface and electrical installations.

G. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 deg F (1 deg 2 C).

H. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.

2. Under building slabs, use drainage fill materials.

3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.

4. For raceways less than 30 inches (750 mm) below surface of roadways, provide 4-inch (100mm)thick concrete base slab support. After installation of raceways, provide a 4-inch (100mm)thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.

5. Other areas, use excavated or borrowed materials.

I. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.

2. Removal of concrete formwork.

3. Removal of shoring and bracing, and backfilling of voids.

4. Removal of trash and debris.

J. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches (200 mm) in loose depth for material compacted by heavy equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

K. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

L. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.

M. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

    a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches (300 mm) of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

    b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

    c. Other Areas: Compact top 6 inches (150 mm) of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.

N. Subsidence: Where subsidence occurs at electrical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.6 CONCRETE ENCASEMENT FOR UNDERGROUND CONDUIT BANKS

A. Utilize the sides of the trench in formwork for underground conduit banks to the maximum extent possible. Utilize a splashboard to divert the concrete flow away from the trench sides to avoid dislodging soil and stones.

B. Provide reinforcement where required. Verify that any required reinforcement is installed prior to commencing placement of concrete.

C. Place concrete in accordance with the following:

1. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete," and as specified.

2. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened sufficiently to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation at its final location.

3. Cold-Weather Placement: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions or low temperatures.

4. When air temperature has fallen to or is expected to fall below 40 F (4 C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 F (10 C) and not more than 80 F (27 C) at point of placement.

    a. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

    b. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

5. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.7 FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements upon completion of installation of underground duct and utility structures.

1. Duct Integrity: Rod ducts with a mandrel 1/4 inch (6 mm) smaller in diameter than internal diameter of ducts. Where rodding indicates obstructions in ducts, remove the obstructions and retest.

B. Correct installations where possible, and retest to demonstrate compliance. Otherwise, remove and replace defective products and retest.

3.8 CLEANING

A. Pull brush through full length of ducts. Use round bristle brush with a diameter ½ inch (12 mm) greater than internal diameter of duct.

END OF SECTION 26 05 43
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SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 07 84 13 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data: For sealants, documentation including printed statement of VOC content indicating compliance.
2. Laboratory Test Reports: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

D. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.

2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).

b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, available 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 Company (The).

d. Pipeline Seal and Insulator, Inc.

e. Proco Products, Inc.

2. Sealing Elements: EPDM or Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Stainless steel.

4. Connecting Bolts and Nuts: Stainless Steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Presealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2. Sealant shall have VOC content of compliant with LEED when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "Joint Sealants."

b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

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

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 05 44

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SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.
9. Identification of receptacles.

1.3 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70 as amended by State and Local Codes.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.

2. Legend: Indicate voltage and system or service type.

C. Colors for Raceways Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.

2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch (75-mm) high letters on 20-inch (500-mm) centers.

D. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

E. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

G. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers diagonally over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stop stripes at legends.

H. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Colors for Cables Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.

2. Legend: Indicate voltage and system or service type.

C. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

D. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

C. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil- (0.08-mm-) thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the cable diameter such that the clear shield overlaps the entire printed legend.

D. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.

E. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

F. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

G. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

H. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil- (0.08-mm-) thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the conductor diameter such that the clear shield overlaps the entire printed legend.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.

E. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around conductor it identifies. Full shrink recovery at a maximum of 200 deg F (93 deg C). Comply with UL 224.

F. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

G. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Labels for Tags: Self-adhesive label, machine-printed with permanent, waterproof, black ink recommended by printer manufacturer, sized for attachment to tag.

2.5 FLOOR MARKING TAPE

A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.

2. Printing on tape shall be permanent and shall not be damaged by burial operations.

3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.

2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.

3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

1. Overall Thickness: 5 mils (0.125 mm).

2. Foil Core Thickness: 0.35 mil (0.00889 mm).

3. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).

4. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbf (311.3 N), and 4600 psi (31.7 MPa).

2.7 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.

2. 1/4-inch (6.4-mm) grommets in corners for mounting.

3. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.

2. 1/4-inch (6.4-mm) grommets in corners for mounting.

3. Nominal size, 10 by 14 inches (250 by 360 mm).

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 48 INCHES (1200 MM)." Adjust clearance dimensions as required for system voltage and equipment configuration.

3. Arc Flash Warning: "POTENTIAL ARC FLASH HAZARD - APPROPRIATE PERSONAL PROTECTIVE EQUIPMENT AND TOOLS REQUIRED WHEN WORKING ON THIS EQUIPMENT."

2.8 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved legend with black letters on white face.

2. Punched or drilled for mechanical fasteners.

3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.9 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).

3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).

3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

4. Color: Black.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch (5 mm).

2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).

3. UL 94 Flame Rating: 94V-0.

4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).

5. Color: Black.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.

G. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.

2. In Spaces Handling Environmental Air: Plenum rated.

3. Identification labels to be provided on all receptacles indicating panel and circuit #.

J. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

K. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.

2. Power.

B. Power-Circuit Conductor Identification, 600 V or Less:

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.

b. Colors for 208/120-V Circuits:

1) Phase A: Black.

2) Phase B: Red.

3) Phase C: Blue.

4) Neutral White

5) Ground Green

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.

2) Phase B: Orange.

3) Phase C: Yellow.

4) Neutral Gray

5) Ground Green

2. For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

3. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

C. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.

D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use write-on tags or self-adhesive, self-laminating polyester labels with the conductor or cable designation, origin, and destination.

F. Control-Circuit Conductor Termination Identification: For identification at terminations provide heat-shrink preprinted tubes or self-adhesive, self-laminating polyester labels with the conductor designation.

G. Ground fault interrupter outlets: Identify receptacles supplied by ground fault interrupter circuit breakers or by upstream ground fault interrupter receptacles. Use engraved letters on device plate.

H. Automatically controlled outlets: Identify receptacles controlled by automatic controls (time switch, occupancy sensor, etc.) with the "controlled receptacle marking symbol" engraved into the device plate.

I. Conductors to Be Extended in the Future: Attach write-on tags or marker tape to conductors and list source and circuit number.

J. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

K. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.

2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

L. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.

1. Comply with 29 CFR 1910.145.

2. Identify system voltage with black letters on an orange background.

3. Apply to exterior of door, cover, or other access.

4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

a. Power transfer switches.

b. Controls with external control power connections.

5. Service equipment shall be labeled with the maximum available fault current. Label shall indicate date fault current calculation was performed.

6. Switchboards, Panelboards, Equipment Control Panels, Meter Socket Enclosures, and Motor Control Centers: Labeled to warn of potential electric arc flash hazards. The label shall be located so as to be clearly visible before examination, adjustment, servicing, or maintenance of the equipment.

7. Generators, Transfer Switches, Panels, Boxes, and Enclosures for Emergency Systems: Identify with "EMERGENCY" in black letters on a yellow background, or with yellow coloring.

N. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

O. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.

P. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

    a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.

    b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.

    c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

    d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

    a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved laminated acrylic or melamine label.

    b. Enclosures and electrical cabinets.

    c. Access doors and panels for concealed electrical items.

    d. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.

    e. Substations.

    f. Emergency system boxes and enclosures.

    g. Motor-control centers.

    h. Enclosed switches.

    i. Enclosed circuit breakers.

    j. Enclosed controllers.

    k. Variable-speed controllers.

    l. Push-button stations.

    m. Power transfer equipment.

    n. Contactors.

    o. Remote-controlled switches, dimmer modules, and control devices.

p. Power-generating units.

q. Monitoring and control equipment.

r. Receptacles

END OF SECTION 26 05 53

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SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC FLASH HAZARD ASSESSMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes computer-based, fault-current and overcurrent protective device coordination, including ground fault studies and the setting of these devices. Protective devices shall be set based on results of the protective device coordination study.

1. Coordination of series-rated devices is permitted except where fully rated systems are required.

B. The arc flash hazard assessment shall be in compliance with the applicable standards for installations (NEC) and for worker safety in operating facilities (OSHA 29 CFR 1910, NFPA 70E-2018).

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

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

1. Section 26 05 00 “Common Work Results for Electrical”.

2. Section 26 28 02 “Selection of Overcurrent”.

3. Section 26 28 13 “Fuses”.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Other Action Submittals:

1. Coordination-study input data, including completed computer program input data sheets.

2. Coordination-study report.

3. Equipment evaluation report.

4. Setting report, including setting tables.

5. Flash hazard analysis.

6. Recommendations.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. Comply with NFPA 70 as amended by state and local codes.

F. Comply with NFPA 70E for flash hazard analysis.

G. IEEE 1584 guide for performing arc-flash hazard calculations.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:

1. CYME International, part of Eaton.

2. EDSA Micro Corporation.

3. ETAP

4. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.

C. Computer software program shall be capable of plotting and diagraming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer generated time-current plots.

1. Required Features: Arcing faults NFPA 70E.

2. Optional Features: Simultaneous faults.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.

B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Impedance of utility service entrance.

3. Electrical distribution system diagram showing the following:

a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment.

b. Circuit-breaker and fuse-current ratings and types.

c. Relays and associated power and current transformer ratings and ratios.

d. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.

e. Generator kilovolt amperes, size rating, impedance, and reactance.

f. Cables. Indicate conduit material, sizes of conductors, conductor material, conductor insulation, and length.

g. Busway ampacity and impedance.

h. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:

a. Special load considerations, including starting inrush currents and frequent starting and stopping.

b. Magnetic inrush current overload capabilities of transformers.

c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

d. Generator thermal damage curve.

e. Ratings, types, and settings of utility company's overcurrent protective devices.

f. Special overcurrent protective device settings or types stipulated by utility company.

g. Time-current-characteristic curves of devices indicated to be coordinated.

h. Manufacturer, frame size, interrupting rating in amperes RMS symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes RMS symmetrical.

3.3 FAULT-CURRENT STUDY

A. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values.

B. Calculate momentary and interrupting duties on the basis of maximum available fault current.

C. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:

1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.

2. Low-Voltage Fuses: IEEE C37.46.

3. Medium-Voltage Circuit Breakers: IEEE C37.010.

4. Medium-Voltage Fuses: ANSI C37.40

D. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (½-cycle) fault currents on the report electrical distribution system diagram.

2. Show interrupting rating (5 cycle) and time delayed currents (6 cycles and above) on medium –voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

E. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices by comparing fault-current ratings of these devices with calculated fault-currents. Recommend settings as required.

1. For low-voltage (600V and below) overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated ½-cycle symmetrical fault current.

2. For devices and equipment rated for symmetrical fault current, apply multiplication factors listed in the standards to ½- cycle fault current.

3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated ½ -cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.

1. Calculate the maximum and minimum ½ -cycle short-circuit currents.

2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.

3. Calculate the maximum and minimum ground-fault currents.

B. Comply with NFPA 70, as amended by state and local codes for coordination of devices, and for overcurrent protection of circuit elements and devices.

1. Emergency Systems and Legally Required Standby Systems and Elevator Feeders: Distribution system shall be selectively coordinated. Series rated devices shall not be used for distribution, regardless of any indication to the contrary.

C. Comply with IEEE 242 (Buff Book) recommendations for fault currents and time intervals.

D. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.

b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformer according to IEEE C57.12.00, for fault currents.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.

b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.

c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.

d. Fuse-current rating and type.

e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is from local generation. Show the following specific information:

a. Device tag.

b. Voltage and current ratio for curves.

c. Three-phase and single-phase damage points for each transformer.

d. No damage, melting, and clearing curves for fuses.

e. Cable damage curves.

f. Transformer inrush points.

g. Maximum fault-current cutoff point.

3. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH STUDY

A. An incident energy study shall be done in accordance with the IEEE 1584-2018, "IEEE Guide for Performing Arc Flash Hazard Calculations" as referenced in NFPA 70E, "Standard for Electrical Safety in the Workplace", 2018 Revision, in order to quantify the hazard for selection of personal protection equipment (PPE). Tables that assume fault current levels and clearing time for proper PPE selection are not acceptable.

B. Incident energy report: Incident energy level (calories/cm2) for each equipment location and recommended PPE.

C. Labels: Based on the results of the incident energy study, produce and install a warning label (orange <40 cal/cm2) or danger label (red >40 cal/cm2) for each piece of electrical equipment in accordance with ANSI Z535.4-2011 (R2017). The label must be readable in both indoor and outdoor environments for at least 3 years and contain the following information:

1. Arc hazard boundary (inches)

2. Working distance (inches)

3. Arc flash incident energy at the working distance (calories/cm2)

4. PPE category and description including the glove rating.

5. Voltage rating of the equipment.

6. Limited approach distance (inches)

7. Restricted approach distance (inches)

8. Prohibited approach distance (inches)

9. Equipment/bus name

10. Date prepared

11. Name and address

D. Safety training: Provide one day of arc flash training that contains the requirements referenced in OSHA 1910.269, OSHA 1910 Subpart S and NFPA 70E. This shall include:

1. Proper use of the system analysis data

2. Interpretation of the hazard labels

3. Selection and utilization of personal protective equipment

4. Safe work and practices and procedures

5. Provide an outline of the one day training course including training materials at time of quotation.

END OF SECTION 26 05 73

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SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cloud-base lighting controls system.

2. Daylight-harvesting switching controls.

3. Indoor occupancy sensors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.

2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIGHTING CONTROL SYSTEM

A. Provide a lighting control system with cloud-base management hub to control all spaces The lighting control system shall be by one of the following manufacturer.

1. Enlighted . (Basis of Design)
2. Lutron :

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Description: Solid state, with SPST DPST dry contacts rated for 1800 VA, to operate connected load, complying with UL 773.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range.

3. Time Delay: Thirty-second minimum, to prevent false operation.

4. Lightning Arrester: Air-gap type.

5. Mounting: Twist lock complying with NEMA C136.10, with base.

2.3 DAYLIGHT-HARVESTING SWITCHING CONTROLS

A. Refer to lighting control drawings for daylight harvesting and switching requirements.

B. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack, to detect changes in indoor lighting levels that are perceived by the eye.

C. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).

3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. Sensor is powered by the power pack.

4. For power pack requirements refer to lighting controls drawings.

5. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lux), with an adjustment for turn-on and turn-off levels within that range.

6. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lux), with an adjustment for turn-on and turn-off levels within that range.

7. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.

8. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.

9. Test Mode: User selectable, overriding programmed time delay to allow settings check.

10. Control Load Status: User selectable to confirm that load wiring is correct.

11. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS

A. Refer to lighting controls for daylight controls requirements.

B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.

1. Lighting control set point is based on two lighting conditions:

a. When no daylight is present (target level).

b. When significant daylight is present.

2. System programming is done with two hand-held, remote-control tools.

a. Initial setup tool.

b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Sensor Output: 0- to 10-V dc to operate electronic dimming ballasts. Sensor is powered by controller unit.

3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.

4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).

2.5 INDOOR OCCUPANCY SENSORS

A. Refer to lighting controls drawings for specifics on the type of sensor required for individual spaces. :

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.

4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.

5. Mounting:

   a. Sensor: Suitable for mounting in any position on a standard outlet box.

   b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.

   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.

7. Bypass Switch: Override the "on" function in case of sensor failure.

8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.

C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).

2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.

D. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).

2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).

E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.

2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.6 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. For specific details on sensor requirements refer to lighting control drawings:

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application , and shall comply with California Title 24.

2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).

2.7 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller thanNo. 14 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting control panel.

B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Lighting control devices will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

3.6 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 26 09 43.13 "Addressable-Fixture Lighting Controls" and Section 26 09 43.23 "Relay-Based Lighting Controls."

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23

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SECTION 26 11 16 - SECONDARY UNIT SUBSTATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes indoor and outdoor secondary unit substations, each consisting of the following:

1. Primary incoming section.

2. Transformer.

3. Secondary distribution section.

B. Related Sections include the following:

1. Section 26 05 13 "Medium-Voltage Cables" for requirements of terminating cables in incoming section of substation.

2. Section 26 05 73 "Overcurrent Protective Device Coordination and ARC Flash Hazard Assessment" for short-circuit rating of devices and for setting of overcurrent protective devices.

3. Section 26 13 00 "Medium-Voltage Switchgear" for metering and instrument transformers.

4. Section 26 43 13 "Surge Protective Devices" for transient voltage surge suppressors for low-voltage power, control, and communication equipment that may be located in secondary section.

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

2. Dimensioned plans and elevations showing major components and features.

3. One-line diagram.

4. List of materials.

5. Nameplate legends.

6. Size and number of bus bars and current rating for each bus, including mains and branches of phase, neutral, and ground buses.

7. Short-time and short-circuit current ratings of secondary unit substations and components.

8. Ratings of individual protective devices.

C. Time-Current Characteristic Curves: For overcurrent protective devices.

D. Primary Fuses: Submit recommendations and size calculations.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Dimensioned concrete base, outline of secondary unit substation, conduit entries, and ground rod locations.

2. Location of structural supports for structure-supported raceways.

3. Location of lighting fixtures, sprinkler piping and heads, ducts, and diffusers.

B. Qualification Data: For testing agency.

C. Product Certificates: For secondary unit substations, signed by product manufacturer.

D. Factory test reports.

E. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For secondary unit substations and accessories to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare fuses: Six of each type and rating of fuse and fusible device used, except for medium-voltage fuses. Include spares for the following:

a. Primary disconnect fuses.
b. Potential transformer fuses.
c. Control power fuses.
d. Fuses and fusible devices for fused circuit breakers.
e. Fuses for secondary fusible devices.

2. Spare Indicating Lights: Six of each type installed.

3. Touchup Paint: Three half-pint containers of paint matching enclosure's exterior finish.

4. Primary Switch Contact Lubricant: One container(s).

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain secondary unit substation through one source from a single manufacturer.

B. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C2.

D. Comply with IEEE C37.121.

E. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

B. Coordinate delivery of secondary unit substations to allow movement into designated space.

C. Store secondary unit substation components protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

D. Handle secondary unit substation components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.10 PROJECT CONDITIONS

A. Field Measurements: Indicate measurements on Shop Drawings.

B. Service Conditions: IEEE C37.121, usual service conditions, except for the following:

1. Exposure to significant solar radiation.

2. Altitudes above 3300 feet (1000 m).

3. Exposure to hot and humid climate.

4. Exposure to seismic shock or to abnormal vibration, shock, or tilting.

5. Exposure to excessively high or low temperatures.

1.11 COORDINATION

A. Coordinate layout and installation of secondary unit substations with other construction that penetrates floors and ceilings, or is supported by them, including light fixtures, HVAC equipment, and fire-suppression-system components.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Front accessible equipment (Basis of design).
2. GE by ABB.
3. Siemens Energy & Automation, Inc.
4. Square D; Schneider Electric.

B. Alternate manufactured listed above shall modify there equipment as required to me the physical requirements as noted on the contract documents.

2.2 MANUFACTURED UNITS

A. Indoor Unit Arrangement: Separate secondary distribution equipment connected with busway.

B. Enclosure Finish: Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.

2.3 INCOMING SECTION

A. Primary Incoming Section: Enclosed, air-interrupter, narrow dual primary switch.

1. Three pole, single throw, dead front, metal enclosed, with manual stored energy operator, with fuses mounted on a single frame, complying with IEEE C37.20.3.

2. Key interlocking system to prevent fuse access door from being opened unless switch is open. Additionally, interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open.

3. Phase Barriers: Located between blades and fuses of each phase, designed for easy removal, allows visual inspection of switch components when barrier is in place.

4. Window: Permits viewing switch-blade positions when door is closed.

5. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.

6. Continuous-Current Rating: 600 A.

7. Short-Circuit Rating:

   a. Short-time momentary asymmetrical fault rating of 40 kA.
   b. 3-second symmetrical rating of 25-kA RMS.
   c. Fault close asymmetrical rating of 40 kA.

8. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading. Comply with the following:

   a. Current-limiting type, rated for not less than 50-kA RMS symmetrical current-interrupting capacity.
   b. Indicator integral with each fuse to show when it has blown.
   c. Spares: Include three fuses in use and three spare fuses in storage clips in each switch.

B. Surge Arresters: Comply with IEEE C62.11, Distribution class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of any disconnecting device.

2.4 TRANSFORMER SECTION

1. Coordinate rating with circuit voltage.

2. Comply with NEMA LA 1.

3. Comply with NFPA 70, Article 280 “Surge Arresters”.

4. Comply with NFPA 780, “Standard for the Installation of Lightning Protection Systems”.

5. Comply with UL 96A.

6. General: Comply with requirements of Division 26 Section “Medium Voltage Transformers.”

2.5 SECONDARY DISTRIBUTION SECTION

A. Secondary Distribution: Low-voltage UL 891 Switchboard with Fixed mounted Molded- Case Circuit Breaker.

2.6 IDENTIFICATION DEVICES

A. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90. Conduct switchgear and switchboard tests according to ANSI C37.51.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of work.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.

D. Verify that ground connections are in place and that requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install secondary unit substations on concrete bases.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit and 4 inches (100 mm) high.

2. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."

3. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.

4. Install epoxy-coated anchor bolts for anchoring equipment to the concrete base.

5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

6. Bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Section 26 05 53 "Identification for Electrical Systems."

B. Operating Instructions: Frame printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of secondary unit substation.

3.4 CONNECTIONS

A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test according to NETA ATS. Certify compliance with test parameters.

2. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation tested at the specified value or less.

3. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.

4. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

    a. Remove and replace malfunctioning units and retest as specified above.

3.7 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.

2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

   a. Adjust transformer taps.
   b. Rebalance loads.

3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.

4. Report: Prepare a written report covering monitoring performed and corrective action taken.

B. Infrared Scanning: Perform as specified in Section 26 13 00 "Medium-Voltage Switchgear."

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 26 11 16

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SECTION 26 12 00 - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section includes the following basic electrical materials and methods to complement other Division 26 Sections.

B. This Section includes the following types of transformers with medium-voltage primaries:

1. Dry- Type distribution and power transformers.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

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

1. Section 26 05 00 “Common Work Results for Electrical”.

2. This section is a part of each Division 26.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.

B. Field quality-control test reports.

C. Follow-up service reports.

D. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with IEEE C2.

C. Comply with ANSI C57.12.28, IEEE C57.12.10, IEEE C57.12.70, and IEEE C57.12.80.

D. Comply with NFPA 70 as amended by state and local codes.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store transformers protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

1.6 COORDINATION

A. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Eaton. (Basis of Design)

2. Siemens Energy & Automation, Inc.

3. Schneider Electric/Square D.

B. Alternate manufactured listed above shall modify there equipment as required to me the physical requirements as noted on the contract documents.

2.2 DRY-TYPE DISTRIBUTION AND POWER TRANSFORMERS

A. Description: ANSI C57.12.50, dry-type, 2-winding transformers.

1. Indoor ventilated vacuum - pressure impregnated with insulation system rated at 220 deg C with an 115 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.

B. Windings Material: Copper.

C. Primary Connection: Metal-enclosed primary switchgear.

D. Secondary Connection: UL 891 Switchboard with Fixed- Mounted Molded -case CB.

E. Insulation Materials: IEEE C57.12.01, rated at 220 deg C.

F. Insulation Temperature Rise: 80 deg C, maximum rise above 40 deg C.

G. Basic Impulse Level: 95 KV.

H. Comply with Department of Energy 2016 efficiency requirements.

I. Full-Capacity Voltage Taps: Four nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.

J. Sound level may not exceed sound levels listed in NEMA TR 1, without fans operating.

2.3 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Electrical Identification."

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to ANSI C57.12.50.

B. Factory Tests: Perform the following factory-certified tests on each transformer:

1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.

2. Ratios on rated-voltage connection and on tap extreme connections.

3. Polarity and phase relation on rated-voltage connection.

4. No-load loss at rated voltage on rated-voltage connection.

5. Excitation current at rated voltage on rated-voltage connection.

6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.

7. Applied potential.

8. Induced potential.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install transformers on concrete bases.

1. Anchor transformers according to manufacturer's written instructions.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70 as amended by state and local codes.

C. Installation shall conform to the physical dimensions as noted on the contract drawings.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Electrical Identification."

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.

2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.

3. Perform electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.2. Certify compliance with test parameters.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove malfunctioning units, replace with new units, and retest as specified above.

D. Test Reports: Prepare written reports to record the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

3.6 FOLLOW-UP SERVICE

A. Infrared Scanning: Perform as specified in Division 26 Section "Medium-Voltage Switchgear."

END OF SECTION 26 12 00

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SECTION 26 20 01 - FEEDERS AND BRANCH CIRCUITRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes basic requirements for the installation of light and power feeders and circuitry run at less than 600 volts.

B. Related Requirements:

1. Division 26, Section "Raceways and Boxes."

2. Division 26, Section "Conductors and Cables."

3. Division 26, Section "Panelboards."

1.3 ACTION SUBMITTALS

A. Shop Drawings:

1. Circuited up "as-built" drawings and panel directories as called for in the Division 26 related sections.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70, as amended by state and local codes.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Products shall be as specified in the Division 26 related sections.

PART 3 - EXECUTION

3.1 INSTALLATION OF FEEDERS

A. Feeder connections shall be in the phase rotation that establishes proper operation for all equipment supplied.

B. Feeders consisting of multiple cables and raceways shall be arranged such that each raceway of the feeder contains one cable for each phase leg (and one neutral cable if any).

C. Each individual tap off a feeder that consists of multiple cables per phase (and neutral if any) shall be arranged so that all of the cables of a phase leg (and neutral if any) of the feeder are connected to the corresponding phase leg (and neutral if any) of the individual tap.

D. Indications of conductor sizing for three phase and three phase/four wire feeders shall, unless otherwise noted on the drawings, be understood as follows:

1. Three (3) equally sized conductors represents a three phase feeder.

2. Four (4) equally sized conductors represents a three phase/4 wire feeder with 100 percent neutral.

3. Four (4) equally sized conductors plus one (1) smaller conductor represents a three phase/four wire feeder plus ground wire).

4. Three (3) equally sized conductors plus one (1) larger conductor or two (2) equally sized conductors and one smaller conductor represents a three phase/four wire feeder with neutral oversized to accommodate "harmonic-rich" loads plus a ground wire.

3.2 INSTALLATION OF LIGHTING AND APPLIANCE BRANCH CIRCUITRY

A. Circuitry indicated without sizing shall be understood to be lighting and appliance branch circuitry protected at 20 amps or less.

B. Conform all lighting and appliance branch circuitry (regardless of whether protected above or below 20 amps) to the following:

1. Except as noted below, circuitry shall be multi-wire utilizing common neutrals arranged so that no neutral conductor acts as a common wire for more than one circuit conductor connected to the same phase leg of the supply system.

a. Common neutrals shall not be utilized for circuitry runs emanating from panel branches having ground fault interrupting features regardless of any indication to the contrary on the floor plans.

b. Common neutrals shall not be utilized for circuitry runs containing more than three (3) 120 volt receptacle circuits within a single raceway (conduit).

c. Common neutrals shall not be utilized for circuitry runs emanating from panels used for emergency power distribution regardless of any indication to the contrary on the floor plans.

2. Two and three pole branches in panels shall be used respectively for individual single phase load items connected line to line and individual three phase load items.

3. Multi-wire branch circuits shall be supplied by multi-pole circuit breakers.

4. Where circuitry indications require the use of 2-pole and/or 3-pole branch breakers that have not been scheduled, provide in the panelboards the required multi-pole breakers in lieu of the equivalent number of single pole branch breakers. Required quantities of single, two, and three pole branch breakers shall be confirmed prior to ordering panels.

5. Conductors used as common neutrals for multiple (2 or 3) 120 volt branch circuits protected at 20 amps or less shall be #10 AWG where such circuits supply receptacles that are dedicated to - or may be utilized for – "harmonic-rich" loads such as personal computers, computer terminals, word processors, printers, and the like. Accordingly, common neutrals supplying receptacles shall be understood to be #10 AWG under the following conditions:

    a. Wherever so indicated (by note or otherwise) on the drawings.

    b. Throughout all office areas, and data processing spaces.

6. Branch circuitry supplying relay controlled lighting fixtures shall be understood to include all necessary interconnections between the control panels containing the relays and the associated lighting or appliance panels.

7. Under no condition shall any local switch break a neutral conductor.

8. At any location where lighting and appliance branch circuitry is extended from a flush mounted panelboard to a suspended ceiling immediately above, at least four 1-inch empty conduits shall be included (in addition to those required for active circuitry) to permit future wiring escape from the panelboard. The empty conduits shall extend up from the panel and shall terminate in a threaded conduit cap immediately after turning out into the hung ceiling space.

9. Raceway sizes shall conform to standard maximum permissible occupancy requirements except where these are exceeded by other requirements specified elsewhere.

C. Conform lighting and appliance branch circuitry, indicated as being protected at 20 amps or less, to the following:

1. 120 volt circuitry shall be supplied from 15 amp panel branches except as indicated.

    a. Circuitry supplying multi-outlet receptacle circuits shall be connected to 15 amp panel branches unless otherwise noted or specified hereinafter.

2. 277 (265) volt circuitry shall be supplied from 20 amp panel branches.

3. Except as specified below, minimum conductor size shall be #12 AWG.

4. Common neutrals shall not be utilized for circuitry runs containing more than three (3) 120 volt receptacle circuits within a single raceway (conduit) except as noted below.

5. Conductors for 120 volt circuitry extending in excess of 75 feet, from the point of supply, to the first outlet shall be #10 AWG (minimum) copper to the first outlet. Increase beyond #10 AWG if required for compliance with code-mandated voltage drop restrictions.

6. Conductors for 277 (265) volt circuitry extending in excess of 150 feet, from the point of supply, to the first outlet shall be #10 AWG (minimum) copper to the first outlet. Increase beyond #10 AWG if required for compliance with code-mandated voltage drop restrictions.

7. Conductors used in runs consisting of more than six wires (exclusive of grounding conductors) in a single raceway shall be #10 AWG copper minimum. Increase beyond #10 AWG as required to comply with code-mandated derating factors, and as specified hereinbefore.

8. Circuits rated 150 volts or less to ground and 60 amperes or less, single-or 3-phase located as noted below shall be connected to panel branches that are equipped with ground fault interrupting features.

    a. Drinking water coolers.

    b. Bottle fill stations.

    c. Vending machines.

    d. Sump pumps.

    e. Dishwashers.

9. Circuits supplying receptacles that are not of the ground fault circuit interrupting type, and are located as noted below, shall be connected to panel branches that are equipped with ground fault interrupting features.

    a. Receptacles located in bathrooms. Bathrooms shall be defined as spaces containing a basin plus a toilet.

    b. Receptacles located within 6 feet of any sink including those mounted within the cabinets below the sink and including those serving fixed equipment or appliances

    c. Receptacles in wet locations.

    d. Receptacles located in laundry areas including those serving clothes washers and/or dryers

    e. Receptacles in warming pantry kitchens

    f. All receptacles mounted on roof or on building exterior surfaces.

    g. Receptacles intended to serve vending machines, drinking fountains, or water coolers.

10. Circuits supplying pipe tracing cable, snow melting cable, gutter melting cable, and HWAT cable shall be connected to panel branches equipped with 30 ma interrupting features for equipment protection.

D. Where circuitry has not been delineated for lighting fixtures, receptacles, switches and miscellaneous items intended for protection at 20 amps, such items shall be provided with circuitry conforming to the requirements listed below. Prior to installation of circuitry, submit for review floor plans showing circuit numbers, home runs, and interconnecting circuitry for all such items.

1. When circuiting up recessed ceiling lighting fixtures, connect fixtures on the basis of more than one fixture to a single outlet box, in an approved manner, as required to ensure that circuits will not be unnecessarily lightly loaded due to mandated, restrictions on the maximum number of outlets per circuit. Except with special permission, unnecessarily light loading shall be understood to mean, less than 1000 volt amps (VA) on a 120 volt circuit and less than 3200 VA on a 277 volt circuit.

2. The total load on a circuit shall be computed by ascribing volt-amps to individual items on the basis of the following:

ITEM	VOLT-AMPS (VA)
Any lighting fixture.	Input volt-amps as per lighting fixture schedule.
Any outlet with no specific wattage or circuiting instruction indicated.	180 volt amperes
Any outlet (other than for resistance heating) with wattage indicated.	1.15 x Indicated wattage
Any resistance heating outlet with wattage indicated.	1.0 x Indicated wattage
Any fractional HP motor with HP indicated.	2500 x Indicated HP
Any outlet with amps indicated.	120 x Indicated amps

3. Not more than 1300 total VA shall be applied to any 15 amp, 120 volt panel branch circuit nor more than 1450 VA to any 20 amp, 120 volt branch circuit. Not more than 4000 VA shall be applied to any 277 (265) panel branch circuit.

4. A separate 20 amp panel branch circuit supplying no other outlets shall be used for each outlet indicated as an "individual appliance circuit" outlet.

5. Lighting fixture shall be connected to 20 amp panel branch circuits. Solidly connected equipment less than 1300 VA shall be connected to 15 amp panel branch circuits except as indicated or noted herein.

6. Lighting fixtures and receptacles shall not be connected to the same branch circuit.

7. Any installed lighting and appliance branch circuitry, found (as a result of unnecessarily light loading of conductors) to make excessive use of panel branches, shall be rearranged.

8. Circuits shall be balanced on phases at their supply point as evenly as possible.

9. The final arrangement of lighting and appliance branch circuitry shall be fully delineated on the record, or "as-built" drawings called for elsewhere.

END OF SECTION 26 20 01

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SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

2. Control and signal transformers.

1.3 ACTION SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated. Provide transformer maximum inrush current data.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Source quality-control test reports.

C. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.8 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ABB

2. Eaton Electrical Inc.; Cutler Hammer Products

3. Siemens Energy & Automation Inc.

4. Square D; Schneider Electric

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.

2. Coil Material: Copper.

D. Comply with NFPA 70, as amended by state and local codes.

E. Enclosures: Class shall comply with NEMA 250 for the environment in which installed.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Indoor Enclosure: Ventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.

E. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

F. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 80 deg C rise above 40 deg C ambient temperature.

G. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Comply with Department of Energy 2016 efficiency requirements.

H. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.

2. Include special terminal for grounding the shield.

3. Shield Effectiveness:

a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.

b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.

c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

I. Mounting: Transformers up to and including 15 KVA shall be equipped with brackets suitable for wall mounting. Larger than 15 KVA, they shall be suitable for platform or floor mounting.

J. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 CONTROL AND SIGNAL TRANSFORMERS

A. Units comply with NEMA Standard ST 1, and are listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If capacity is not indicated, provide capacity exceeding peak load by 50 percent minimum.

C. Description: Self-cooled, 2-winding, dry type.

D. Enclosure: Suitable for the location where installed.

2.5 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

B. Wall mount transformers 15 KVA and less. Suspend transformers larger than 15 KVA and in sizes up to and including 45 KVA from the structure to overhead. Utilize trapeze type hanger arrangements for the purpose. Floor mount all transformers larger than 45 KVA.

C. Coordinate location of ceiling suspended transformers with building structure and with equipment in closet so as to insure accessibility and working clearances. If necessary, to so insure, floor mount transformers in lieu of suspending them. Modify closet layout accordingly.

D. Floor or wall supported transformers shall be resiliently isolated from the building structure by means of neoprene in shear isolators providing a minimum static deflection of 3/8 inch.

E. Ceiling supported transformers shall be resiliently suspended by means of neoprene in shear hanger rod isolators providing a minimum static deflection of 3/8 inch.

F. All transformers shall have vibration isolation that isolates the case from the core and the coil assembly. Transformer shall be mounted either on floor, wall or suspended from the ceiling as indicated. Additional vibration isolators shall be provided between trapeze or universal hangers of suspended transformer and its case and between transformer case and floor for flor mounted units. Use flexible metallic conduit of 24 inch minimum length, with external grounding jumper for final connection to transformer case.

1. Mountings for suspended transformers shall be Type HD, Mason Industries, Inc., or equal.

2. Mountings for floor supported transformers shall be Type ND, Mason Industries, Inc., or equal.

G. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Brace wall-mounting transformers as specified in Division 26 Section “Seismic Controls for Electrical Work.”.

H. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems."

I. Refer to Division 26 Specifications, Section 26 05 47 “Vibration Controls for Mechanical/Electrical Systems (Non-Seismic)” for vibration isolation requirements.

J. Comply with safety requirements of IEEE C2.

K. Arrange equipment to provide adequate spacing for access and for cooling air circulation.

L. Identify transformers and install warning signs according to Division 26 Section "Electrical Identification."

3.3 CONNECTIONS

A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.

3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 22 00

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SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Power and Distribution panelboards.

2. Lighting and appliance branch-circuit panelboards

1.3 DEFINITIONS

A. Overcurrent Protective Device (OCD) (OCPD): A device operative on excessive current that causes and maintains the interruption of power in the circuit it protects.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

2. Detail enclosure types and details for types other than NEMA 250, Type 1.

3. Detail bus configuration, current, and voltage ratings.

4. Short-circuit current rating of panelboards and overcurrent protective devices.

5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

6. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field Quality-Control Reports:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

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

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.

2. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

3. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70, as amended by state and local codes.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.10 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).

b. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet (2000 m).

1.11 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1

b. Outdoor Locations: NEMA 250, Type 3R

c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

3. Finishes:

a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

b. Back Boxes: Galvanized steel.

4. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

B. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

C. Main Devices: Mounted at top or bottom of panelboard to match incoming feeder. Branch mounted main devices are not acceptable.

2.2 PANELBOARD BUSES

A. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: To match bus material.

2. Feed-Through Lugs: type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

3. Subfeed (Double) Lugs: type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

4. Neutral Lugs: Rated 100 percent of phase lugs.

B. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

C. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

D. Where wires or cables are used within panelboards to make up internal connections (factory installed or otherwise) such wire or cable shall have copper conductors only.

E. Where indicated or as required to assure ready accessibility of top switching and overcurrent device, they shall be arranged as multiple adjacent sections. A single overall cabinet shall be supplied for the multiple adjacent sections that constitute one panel. 1/4 inch (7 mm) minimum thickness plastic barriers having adequate angle iron framing support all around shall be included between sections. The entire assembly shall be such as to include wiring gutter space for each section as if it were an individual panelboard. Common bussing shall be arranged for adjacent sections unless there is indication that the individual sections are to be separately supplied. Sub-feed lugs with full capacity cable taps to adjacent panel sections will be accepted as the bussing method.

F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.3 POWER OR DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. G.E. by ABB.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Main Overcurrent Protective Devices and Branch Overcurrent Protective Devices: as specified in Division 26, Section “Selection of Overcurrent Devices.”

D. Cabinet: width and a depth adequate for a three pole branch device equal in rating to the panel mains. In no case shall the cabinet be wider than 42 inches (106 cm) or deeper than 18 inches (46 cm).

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. G.E. by ABB. GE-A Series 11

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Door in door: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

E. Gutter space: adequate space for connecting to all active and spare branches.

F. Cabinet width: not to exceed 24 inches (61 cm).

G. Cabinet depth: not to exceed 6 inches (15 cm).

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. As described in Division 26 Section “Selection of Overcurrent Devices”.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

C. Switch and fuse units incorporated as part of panelboards shall be equipped with factory installed rejection clips to restrict fuses to types specified in Division 26, Section "Selection of Overcurrent Devices." Modify or replace in field any incorrect fuse clips.

D. Provide "lock-on" clips for the toggle handles of 5 percent of the branches in all lighting and appliance panels. Apply these clips to circuits supplying security, night lights, clocks, fan coil units, fire alarm and others as directed in the field.

E. Furnish handle padlock attachments for 5 percent of the branches in lighting and appliance panels, and padlocks (with key) for 10 percent of these padlock attachments, but not less than 10 locks. Apply the padlock attachments to circuits (as directed in the field) for which the branch circuit device must be lockable in the "off" position in order to provide code-approved disconnect means.

2.7 PANELBOARD SHORT CIRCUIT RATINGS

A. Panelboards shall bear U.L. labels attesting to the adequacy of the equipment to withstand and interrupt short-circuit currents not less than those available at their incoming terminals. Panels shall either be fully rated or shall be series rated in conjunction with integral or remote upstream devices in compliance with Division 26 Section “Selection of Overcurrent Devices”. U.L. labels shall include size and type of allowable upstream and branch circuit devices and series connected ratings.

B. Panelboard short circuit ratings shall comply with the following:

1. 277/480 (265/460) and 480 (460) volt distribution and power panels shall be "fully rated" for 200,000 amps when used in conjunction with appropriate current limiting fuses as specified.

2. 277/480 (265/460) and 480 (460) volt distribution and power panels shall be "fully rated" for not less than 150,000 amps. Coordinate with short circuit study and adjust accordingly.

3. 277/480 (265/460) volt lighting and appliance panels shall be "series connected rated" for not less than 150,000 amps where used in conjunction with appropriate upstream current limiting fuses, or optionally with main or upstream current limiting circuit breakers.

   a. Under the following circumstances, the required series ratings for lighting and appliance panels may be reduced below 150,000 amperes.

      1) For any lighting and appliance panels at which the available short circuit current has been reduced to less than 100,000 amps, the required series short circuit rating may be reduced to 100,000 amps. Submit short circuit calculations demonstrating compliance.

      2) Where the available short circuit current at the secondary service point is less than 95,000 amps, the required short circuit rating for all 277/480 volt lighting and appliance panels may be reduced to 125 percent of that available at the service point or 100,000 amps - whichever is less.

4. 277/480 (265/460) volt lighting and appliance panels shall be series rated for not less than 150,000 amps when used in conjunction with appropriate main or upstream current limiting or high interrupting capacity circuit breakers. Coordinate with short circuit study, adjust accordingly.

5. 120/208 volt power or distribution panels shall be fully rated for not less than 22,000 amps.

6. 120/208 volt lighting or appliance panels shall be "fully rated" for 10,000 amps except that panels supplied from transformers 225 KVA and larger shall be "fully rated" or "series connected" rated for not less than 22,000 amps.

2.8 EMERGENCY SYSTEMS AND LEGALLY REQUIRED STANDBY SYSTEMS:

A. Overcurrent devices shall be selected such that distribution system is selectively coordinated. Series rated devices shall not be used for distribution, regardless of any indication to the contrary. Short circuit rating of panelboards and devices shall be as required for a fully rated system. For lighting and appliance panelboards that are not available with integral main overcurrent devices, provide individually enclosed main device located adjacent to panel complete with interconnecting circuitry.

B. Panels which are part of the emergency power distribution system shall each be equipped with a listed surge protective device (SPD). Include overcurrent protection for the SPD in addition to the branch devices shown on the documents. Increase number of poles in panelboard if required to maintain required quantity of active, spare, and space only devices indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407 and NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Equipment Mounting: Install floor-mounted panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Section 03 30 00 "Cast-in-Place Concrete." and Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.

2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to panelboards.

5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

E. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

H. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 26 05 53 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.

c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73 "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.7 CLEANING

A. In completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 24 16

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SECTION 26 27 14 - ELECTRICITY METERING (ELECTRONIC SUBMETERING SYSTEM)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Sections: The following sections apply to this section:

1. Section 26 05 00 “Common Work Results for Electrical”.

2. Section 26 24 13 “Switchboards”.

3. Section 26 24 16 “Panelboards”.

1.2 SUMMARY

A. Section includes equipment for monitoring usage of electricity metering by Owner.

B. This section includes an electronic submetering system using Data Transmission cable, KY pulse data over Class 1 circuits.

C. Electrical Energy Monitoring

1. Measurement devices shall be installed to monitor the electrical energy use for each of the following separately.

a. Total electrical energy

b. HVAC systems

c. Interior lighting

d. Exterior lighting

e. Receptacle circuits

1.3 DEFINITIONS

A. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.

B. PC: Personal computer.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: For electricity-metering equipment.

1. Dimensioned plans and sections or elevation layouts.

2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports and test reports specified hereinafter.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. Application and operating software documentation.

2. Software licenses.

3. Software service agreement.

4. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 COORDINATION

A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:

1. Comply with requirements of utilities providing electrical power services.

2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY CHECK METERING BY OWNER

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Square D; a brand of Schneider Electric. (Powerlogic System)

B. General Requirements:

1. Comply with UL 1244.

2. Meters shall have an accuracy of 0.5 percent of reading, complying with requirements in ANSI C12.20.

3. Enclosure: NEMA 250, Type 1 minimum, with hasp for padlocking or sealing.

4. Identification: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

5. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.

6. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.

   a. Type: Split or solid core, as applicable.

7. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.

8. Building Automation System (BAS) Interface: One digital KY pulse to a user-definable increment of energy measurement. Match signal to BAS input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.

C. Kilowatt-hour Meter: Electronic single- and three-phase meters, measuring electricity used.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.

2. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kilowatt-hours and current kilowatt load. Retain accumulated kilowatt-hour in a nonvolatile memory, until reset.

D. Kilowatt-hour/Demand Meter: Electronic single- and three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.

2. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kilowatt-hours, current time and date, current demand, historic peak demand, and time and date of historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset.

E. Data Transmission Cable: Transmit KY pulse data over Class 1 control-circuit conductors in raceway. Comply with Section 26 05 23 "Control-Voltage Electrical Power Cables."

F. Software: PC based, a product of meter manufacturer, suitable for calculation of utility cost allocation and billing.

1. Utility Cost Allocation: Automatically import energy-usage records to allocate energy costs for each check meter:

2. Activity Billing Software: Automatically import energy-usage records to automatically compute and prepare activity demand and energy-use statements based on metering of energy use and peak demand. Maintain separate directory for each tenant's historical billing information. Prepare summary reports in user-defined formats and time intervals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.

2. Equipment Identification Labels: Adhesive film labels with clear protective overlay.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.

2. Turn off circuits supplied by metered feeder and secure them in off condition.

3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.

4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.

C. Electricity metering will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 26 27 14

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SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, combination receptacles with USB ports, and associated device plates.

2. Twist-locking receptacles.

3. Receptacles with integral surge-protection devices (SPD's).

4. Tamper-resistant receptacles.

5. Weather-resistant receptacles.

6. Occupancy sensors.

7. Communications outlets.

8. Cord and plug sets.

9. Multioutlet assemblies.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. SPDs: Surge Protective Devices

F. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. Hubbell Incorporated; Wiring Device-Kellems.

2. Leviton Mfg. Company, Inc.

3. Legrand; Pass & Seymour.

4. Eaton Corporation; Arrow Hart.

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70 as amended by state and local codes.

C. Devices shall utilize screw terminals for wiring termination. Push in type connectors are not acceptable.

D. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.

2. Devices shall comply with the requirements in this Section.

E. Provide Rectangular (decorator) style in public spaces.

Tamper resistant in all classrooms and in public spaces including corridors, hallways, lobbies, and other areas used in common by occupants.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

B. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.

1. Description: Labeled shall comply with NFPA 70 Section.

2.4 GFCI RECEPTACLES

A. General Description:

1. Straight blade, feed-through type.

2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.

3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Description: As specified above for convenience receptacles with GFCI features and with feed-thru capability.

C. Tamper-Resistant GFCI Convenience Receptacles, 125 V, 20 A:

1. Description: As specified above for tamper-resistant receptacles and for GFCI receptacles.

2.5 SPD RECEPTACLES

A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 1449, and FS W-C-596, with integral SPD in line to ground, line to neutral, and neutral to ground.

1. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.

2. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

B. Duplex SPD Convenience Receptacles:

1. Description: Straight blade, 125 V, 20 A; NEMA WD 6 Configuration 5-20R.

2.6 DUPLEX CONVENIENCE RECEPTACLE WITH DUPLEX USB CHARGER

A. Tamper resistant convenience straight-blade receptacle 125V, 20A, comply with NEMA WD-1 configuration 5-20R, UL 498.

B. Two 5VDC DC powered USB ports Class 2. Minimum of 3-amperes DC capacity. Part 15 of the FCC rules compliant.

2.7 PENDANT CORD-CONNECTOR DEVICES

A. Description:

1. Matching, locking-type plug and receptacle body connector.

2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.

3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.

4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.8 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A.

2.9 WALL-BOX DIMMERS

A. For lighting controls refer to lighting drawing.

2.10 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Finished Spaces: as selected by Architect.

3. Material for Unfinished Spaces: Galvanized steel.

4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover. Enclosures for 120 Volt receptacles rated 20 Amperes or less shall be weatherproof whether or not the attachment plug cap is inserted.

2.11 FINISHES

A. Device Color:

1. Wiring Devices: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.

2. Wiring Devices Connected to Emergency Power System: Red.

3. SPD Devices: Blue.

4. Where indicated on drawings as supplying power to computer equipment: Grey.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.

2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.

5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

   Do not install receptacles in face-up position unless the receptacle is part of listed furniture assembly, or installed in a listed floor box.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. GFCI devices may be utilized where readily accessible. Where access to device may be blocked by a piece of equipment or door a GFCI type circuit breaker as specified in Section "Selection of Overcurrent Devices" shall be utilized.

H. Dimmers:

1. Install dimmers within terms of their listing.

2. Verify that dimmers used for fan speed control are listed for that application.

3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

I. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

3.2 IDENTIFICATION

A. Comply with Section 26 05 53 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes. Use red-filled lettering for devices supplied by generator.

C. All non-locking type 125 Volt, 15- and 20-ampere receptacles that are controlled by an automatic control device, or that incorporate feature that removes power from the receptacle for the purpose of energy management or building automation, shall be permanently marked with a symbol and the word "controlled". The marking shall be located on the receptacle face.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.

2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.

2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.

3. Ground Impedance: Values of up to 2 ohms are acceptable.

4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

5. Using the test plug, verify that the device and its outlet box are securely mounted.

6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections, replace with new and retest.

D. Prepare test and inspection reports.

END OF SECTION 26 27 26

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SECTION 26 28 04 - SELECTION OF OVERCURRENT DEVICES (CB-RAD)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes all overcurrent protective devices (OCPDs) (OCDs) required for the project. It defines the type of OCPD required for each individually mounted device, panelboard, switchgear, and miscellaneous device required.

B. Related Requirements:

1. Division 26, Section "Enclosed Switches and Circuit Breakers."

2. Division 26, Section "Panelboards."

3. Division 26, Section "Switchgear."

1.3 ACTION SUBMITTALS

A. Shop Drawings:

1. Descriptive data defining how the required short circuit ratings will be met by the equipment furnished under the Related Sections described above. Include UL approval data from manufacturers for "series rated" combinations.

2. In advance of, or in conjunction with, the submission of shop drawings for approval, provide data defining in detail how the required coordination and short circuit current ratings specified elsewhere in these specifications are achieved with the equipment being furnished under the listed Related Sections. The data shall, in narrative or graphic fashion, fully define how the various devices, individually, or in combination, comply with the "fully rated" or "series connected" short circuit current requirements. Include certifications from the manufacturer as to the UL approvals for these ratings for all proposed equipment. Short circuit and coordination study shall include recommended device settings. In particular, demonstrate selective coordination of overcurrent devices used for Emergency Systems.

3. Arc flash study indicating arc flash hazard at each piece of distribution equipment.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70, as amended by state and local codes.

B. Listing and Labeling: Products - as described with the Related Sections above - shall be Underwriters Laboratories listed and labeled as defined in NFPA 70 Article 100. Where "series ratings" have been specified, listings attesting to these ratings shall be provided from UL or other nationally recognized testing laboratory.

PART 2 - PRODUCTS

2.1 GENERAL

A. Refer to Related Sections listed hereinbefore for general product requirements.

B. Short circuit current ratings, and the manufacturer's labels attesting to these ratings (based on UL listings), shall be required for overcurrent protection devices, where they are individually mounted, and for the equipment assemblies when they are incorporated in panels, switchgear, etc. Such ratings shall be in accordance with the following:

1. Overcurrent protection and switching devices shall be suitable for use on a system having an available short circuit current (including motor contribution) of 100,000 RMS symmetrical amperes.

2. In order to ensure that they are at least equal to the available fault current, minimum ratings have been specified herein for the individual overcurrent device types, and in the pertinent sections for panelboards, switchgear, and other assemblies or devices. Where "series connected ratings" have been specified for circuit breaker type panelboards (see specification section "Panelboards"), these minimum ratings are in general based on the use of upstream devices that have been specifically tested with the circuit breakers, and have been U.L. listed accordingly.

3. All overcurrent protection and switching devices shall be U.L. listed as suitable for the termination of 75 degree C conductors, sized in accordance with their 75 degree C ampacity ratings. Devices shall be specifically identified accordingly and shall bear the designation "60 / 75 degree C" or "75 degree C", regardless of whether incorporated in panelboards, switchboards or other assemblies or whether individually mounted.

2.2 APPLICATION

A. Overcurrent protective devices (OCPDs) (OCDs) shall be provided as described hereinafter.

B. Where intended for installation in main switchboards or as individually mounted service switches, they shall be fixed draw out mounted air frame circuit breakers or insulated case circuit breakers (also known as encased power or systems breakers or as stored energy type molded case circuit breakers). They shall be "fully rated" to interrupt the available short circuit current specified above. Increase indicated frame size - or incorporate current limiters if needed for compliance with this short circuit requirement.

C. Where intended for installation in the mains or branches of 277/480 (265/460) or 480 (460) volt power panels, or for use as individually mounted overcurrent protection devices (at this voltage), they shall be of the molded case circuit breaker type, selected so as to be "fully rated" for the available system short circuit current specified above. Increase indicated frame size - or add current limiters - if need to comply with this short circuit requirement.

D. Where intended for installation in the mains or branches of 277/480 (265/460) volt distribution or power panels, they shall be of the molded case circuit breaker type complying with the requirements specified above for OCDs installed in power panels. Where they serve feeders supplying downstream 277/480 (265/460) volt lighting or appliance panels, they shall be UL listed (in conjunction with OCDs in the downstream panels) as providing a "series connected" short circuit rating for the downstream OCDs that is equal to the available system short circuit current specified above and in the "Panelboards" section of these specifications. Main circuit breakers in these downstream panels may be utilized to provide these "series connected" ratings - if so listed by UL - and may be added to such panels (if not already so provided) to avoid the need for this to be accomplished by the OCDs in the distribution panel.

E. Where intended for installation in the branches of 277/480 (265/460) volt lighting or appliance panels, they shall be of the molded case type having an interrupting capacity of 14,000 amps RMS symmetrical at 277/480 volts. They shall be UL listed as being "series rated" in conjunction with upstream OCDs (either in the mains of the panels or further upstream) so as to ensure their adequacy for the available system short circuit current specified above, and in the "Panelboards" section of these specifications.

F. Where intended for use in 120/208 volt distribution or power panels, or for use as individually mounted 120/208 volt OCDs, they shall be of the molded case circuit breaker type, and shall be fully rated for a short circuit current of 22,000 amps RMS symmetrical. Where supplied from 480-120/208 volt stepdown transformers larger than 150 KVA, they shall be UL listed as suitable for providing a "series connected" rating of 22,000 amps for OCDs in downstream 120/208 volt lighting or appliance panels.

G. Where intended for use in 120/208 volt lighting or appliance panels, they shall be of the molded case circuit breaker type, "fully rated" for a short circuit current of at least 22,000 amps or as required by the short circuit study. Where supplied from 480-120/208 volt stepdown transformers larger than 150 KVA they shall be "series rated" for 22,000 amps in conjunction with upstream OCDs (either main OCDs in the panels, or remotely mounted devices).

H. Emergency Systems and Legally Required Standby Systems: Overcurrent devices shall be selected such that all overcurrent devices in the distribution system are selectively coordinated.

1. Regardless of indications otherwise, all overcurrent devices for Emergency Systems shall be switch and fuse type. Devices up to and including 800 amperes shall be quick-make, quick-break type switches with cartridge fuses. This requirement includes all overcurrent devices providing utility service to the transfer switches, providing generator power to the transfer switches, and on the load side of transfer switches - including branch circuit overcurrent protection.

2. Short circuit rating of panelboards and devices shall be as required to provide a fully rated system.

2.3 MOLDED CASE CIRCUIT BREAKERS

A. Molded case circuit breakers shall comply with the following:

1. Their tripping units shall be of the "thermal magnetic" type having bimetallic elements for time delay overload projection, and magnetic elements for short circuit protection.

2. Where no frame sizes are indicated their interrupting capacity (in RMS symmetrical amperes) shall not be less than 14,000 amperes for use in 277/480 (265/460) volt lighting and appliance panels, nor less than 10,000 amperes for use in 120/208 volt lighting or appliance panels.

3. Where frame sizes are indicated their interrupting capacity (in RMS symmetrical amperes) shall not be less than 22,000 amperes for 100 ampere and 225 ampere frame circuit breakers, nor less than 42,000 amperes for larger frame sizes.

4. The minimum interrupting capacities of the circuit breakers specified above shall be increased as required to comply with previously stated short circuit requirements for "fully rated" OCDs and for UL listed "series connected" rated combinations of OCDs in lighting and appliance panels with upstream OCDs.

5. The minimum interrupting capacity in symmetrical RMS amperes of the circuit breakers intended for use in panelboards shall be as noted above. Where necessary in order to provide the UL approved "series connected" short circuit panel ratings in Division 26, Section "Panelboards," breakers with higher interrupting capacities shall be provided as required.

6. They shall be of the "bolted-in" type.

7. Single pole breakers sized 20 amps or less shall be rated for switching duty.

8. They shall be multi-pole circuit breakers, or single-pole circuit breakers with handle ties where serving multi-wire branch circuits.

9. They shall be equipped with 5 milliamp sensitivity ground fault interrupting features where so indicated, and/or where they supply 120 volt, 15- and 20-ampere receptacles in bathrooms, kitchens, within 6 feet of sinks, where intended for use by vending machines, and other such code mandated locations and with 30 milliamps sensitivity GFPE features where they supply piping tracing cables or snow melting cables or gutter de-icing cables or HWAT cables.

10. They shall include provisions for padlocking the device in the open position where serving loads that require such protection.

2.4 COMPACT MOLDED CASE CIRCUIT BREAKERS

A. Select compact molded case breakers in accordance with the following:

1. They shall consist of manually operated quick-make, quick-break mechanically trip free operating mechanisms for simultaneous operating of all poles, with contacts, and trip elements for each pole, all enclosed in molded phenolic plastic cases. Trip units for these breakers shall be of the "thermal-magnetic" type having bimetallic elements for time delay overload protection and magnetic elements for short circuit protection.

2. They shall have an interrupting rating of at least 22,000 amperes RMS asymmetrical.

3. They shall be of a type capable of being used with main devices incorporated in the panel or upstream devices, to establish the required series rated short circuit capability indicated elsewhere.

4. They shall be equipped with 5 milliamp ground fault interrupting features where so indicated or where required by code.

2.5 QUICK-MAKE, QUICK-BREAK SWITCHES

A. Select quick-make, quick-break type distribution switches in accordance with the following:

1. They shall equal or exceed the performance required for NEMA type H.D. horsepower rated switches.

2. They shall have arc quenchers and circuit breaker type pressure contacts.

3. Where intended for panelboard mounting, they shall be of the "bolted-in" type.

4. They shall be designed for use only with "Class L" fuses above 600 amps. Where protecting a branch circuit for emergency systems and legally required standby systems, fuses shall be current limiting type. They shall incorporate factory installed clips designed to ensure the use of proper fuses. Coordinate to ensure that fuses supplied for the project match these fuse gaps.

5. Switches 400 amperes or larger shall be equipped with an Open Fuse Trip Device arranged to trip switch open if a phase fuse opens.

2.6 FUSES

A. Select fuses for use in switch and fuse type overcurrent devices in accordance with the following:

1. Regardless of the actual available fault current they shall, at full recovery voltage, be capable of safely interrupting fault currents of 200,000 amperes RMS symmetrical deliverable at the line side of the fuse.

2. They shall be suitable for application to fuse gaps that reject other types of fusing. Coordinate with supplier(s) of all fusible switch units (in panels, etc.) for the project to ensure that fuse gaps match the specified fuse types.

3. Except as noted hereinafter, in sizes up to 600 amps, they shall be of the Class "L" time delay type. Approval is contingent on certified test data demonstrating full compliance with the following requirements:

a. Fuse shall carry 500 percent of rating for at least 10 seconds.

b. Fuse shall be suitable for motor feeders when applied at 150 percent of motor full load current.

c. Fuse selectivity with downstream fuses shall be:

1) 2:1 with "L" time delay.

2) 3:1 with "RK-5" time delay.

3) 2:1 with "RK-1" time delay.

4. Where intended for use in motor starters (individual, or in motor control centers) they shall be of the dual element time delay type, UL listed as "Class RK-5", and capable of carrying 500 percent of rating for at least 10 seconds. Utilize "Class RK-1" time delay fuses where required to ensure coordination with upstream fuses.

5. Where protecting a branch circuit fuses shall be current limiting type.

6. In sizes over 600 amps, except as noted hereinafter, they shall be of the current limiting type, UL listed as "Class L".

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the requirements of Division 26 Sections "Enclosed Switches and Circuit Breakers," "Fuses," "Panelboards," "Switchgear".

B. Submit recommended settings for all adjustable or interchangeable overcurrent and ground fault tripping devices. Include a complete short circuit and coordination study to demonstrate that the recommended device settings will provide a completely coordinated system based on the available fault currents, except where "full" coordination is not possible due to the series rating of devices and/or where instantaneous trip devices are in series. Full coordination of all devices used for Emergency Systems. Include all work required in the field to verify that factory settings are as recommended, and to field set device whose settings are not as recommended.

END OF SECTION 26 28 04

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SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in control circuits enclosed switches panelboards enclosed controllers and motor-control centers.

2. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.

b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.

3. Current-limitation curves for fuses with current-limiting characteristics.

4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.

5. Coordination charts and tables and related data.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.

2. Current-limitation curves for fuses with current-limiting characteristics.

3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.

4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70; including the amendments of local jurisdiction.

1.7 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.8 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Bussmann, an Eaton business
2. Edison, a brand of Bussman by Eaton
3. Mersen, USA.
4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.

2. Finish: Gray, baked enamel.

3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.

4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s).

3.3 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 26 28 13

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SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Molded-case switches.
4. Molded-case circuit breakers (MCCBs).
5. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

2. Fuse Pullers: Two for each size and type.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70 as amended by state and local codes.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).

2. Altitude: Not exceeding 6600 feet (2010 m).

1.9 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. GE by ABB..

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Service switches on 277/480 volt system shall have shunt trip mechanisms suitable for operation in response to manual activation, or automatic operation in response to ground fault relay.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

5. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.

6. Lugs: Suitable for number, size, and conductor material.

7. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. GE by ABB.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.

5. Hookstick Handle: Allows use of a hookstick to operate the handle.

6. Lugs: Suitable for number, size, and conductor material.

D. Where used as an in-sight disconnect where six conductors are required between the motor controller and the motor, switch shall be a six pole device regardless of indications on the drawings.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. GE by ABB.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Refer to Division 26 Section “Selection of Overcurrent Devices” for additional information.

2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

2. Outdoor Locations: NEMA 250, Type 3R.

3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

5. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosures before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.4 CONNECTIONS

A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.

B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as required by overcurrent protective device coordination study.

END OF SECTION 26 28 16

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SECTION 26 29 13 - ENCLOSED CONTROLLERS (INSTALLATION OF)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the installation of A.C. individually enclosed motor controllers rated 600 V and below. The motor controllers will be furnished as part of Division 21, Division 22, and Division 23.

B. Related Section:
1. Division 26 Section “Common Work Results for Electrical” for general materials and installation methods.
2. Division 26 Section “Selection of Overcurrent Devices” for OCPDs and disconnect switches used with motor controllers.
3. Division 23 Section “Enclosed Controllers”.
4. Division 26 Section “Variable Frequency Controllers, Installation of”

1.3 DEFINITIONS

A. MCCB: Molded-case circuit breaker.

B. MCP: Motor circuit protector.

C. OCPD: Overcurrent protective device.

D. VFC: Variable Frequency Controller.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

C. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller.

1.6 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

D. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

E. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 26 05 29 "Hangers and Supports for Electrical Systems."

B. Floor-Mounted Controllers: Install enclosed controllers on 4-inch (100-mm) nominal-thickness concrete base. Comply with requirements for concrete base specified in Section 03 30 00 "Cast-in-Place Concrete" and Section 03 30 53 "Miscellaneous Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Control Devices: Install independently mounted motor control devices in accordance with manufacturer's written instructions.

D. Location: Locate controllers as indicated and within sight of motors controlled. Where controller is not located within sight of the motor controlled (as defined in the National Electrical Code), provide a nonfusible disconnect switch within sight of the motor to serve as the local motor disconnect.

E. Modify as required the internal control of motors if necessary to accommodate connection of external control wiring in accordance with applicable wiring diagrams.

F. Relay settings: Modify factory settings of adjustable time delay relays in accordance with an approved schedule.

G. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

H. Install fuses in each fusible-switch enclosed controller. Comply with requirements in Section 26 28 13 "Fuses."

I. Install fuses in control circuits if not factory installed. Comply with requirements in Section 26 28 13 "Fuses."

J. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

K. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

L. Install power factor correction capacitors. Connect to the load side of overload relays. Adjust overload heater sizes to accommodate the reduced motor full-load currents.

M. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

A. Identify motor control components and control wiring in accordance with Division 26 Section "Electrical Identification." Where not cover mounted on motor controller, device identification nameplate shall identify the associated motors.

B. Control wiring for HVAC motors will be provided as part of the Building Management System (central mechanical control system) work of Division 23, except for the following wiring that is provided as part of the electrical work (Division 26):

C. Control wiring for plumbing/fire protection motors is provided as part of the electrical work. For each such motor, provide wiring and connect to all outlying control devices as directed. Refer to plumbing and fire protection drawings and specifications for quantities and locations.

D. Damper Control Interface: Start command to open associated dampers before the motor is allowed to operate. Input to accept damper limit switch contact closure to allow the motor to operate in hand and auto or remote mode.

E. Safety Control Interface: Input to accept safety device contact closure to stop motor operation in hand and auto or remote mode.

F. Control wiring is accomplished utilizing #14 AWG copper conductors with THWN insulation run in conduit as specified for feeders in Division 26, Section "Raceways."

G. Include any necessary field installed make-up wiring (within motor controller enclosures) as required to incorporate the contained devices and accessories into the control scheme.

H. Install wiring between enclosed controllers and remote devices. Comply with requirements in Section 26 05 23 "Control-Voltage Electrical Power Cables."

I. Bundle, train, and support wiring in enclosures.

J. Connect selector switches and other automatic-control selection devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
   2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect, Construction Manager, and Owner before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multi-pole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multi-pole enclosed controller 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed controllers will be considered defective if they do not pass tests and inspections.

E. Provide test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cool down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

F. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73 "Overcurrent Protective Device Coordination Study."

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers, and to use and reprogram microprocessor-based, reduced-voltage solid-state controllers.

END OF SECTION 26 29 13

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SECTION 26 32 13 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes packaged engine-generator sets for emergency standby power supply with the following features:

1. Diesel engine.
2. Unit-mounted cooling system.
3. Remote-mounting control and monitoring.
4. Performance requirements for sensitive loads.
5. Load bank.
6. Outdoor enclosure.
7. Sub-base Day tank.
8. Starting battery.
9. Battery charger.
10. Remote stop switch.
11. Muffler.

B. Related Sections include the following:

1. Section 26 36 00 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. Standby Rating: Power output rating equal to the power the generator set delivers continuously under normally varying load factors for the duration of a power outage.

C. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hz or cycles per second.

D. EPS: Emergency power supply.

E. EPSS: Emergency power supply system.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.

2. Time-current characteristic curves for generator protective device.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set, and other components specified.

2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.

4. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Source quality-control test reports.

1. Certified summary of prototype-unit test report.

2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

3. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.

4. Report of sound generation.

5. Report of exhaust emissions showing compliance with applicable regulations.

6. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

C. Field quality-control test reports.

D. Warranty: Special warranty specified in this Section.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

2. Operating instructions laminated and mounted adjacent to generator location.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.

2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.

3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 6 hours travel time of project site, a service center capable of providing training, parts, and emergency maintenance repairs.

B. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with ASME B15.1.

E. Comply with NFPA 30.

F. Comply with NFPA 37.

G. Comply with NFPA 70.

H. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

I. Comply with UL 2200.

J. Comply with ASCE/SEI 7.

K. Engine Exhaust Emissions: Comply with applicable federal, state and local government requirements, including published requirements that will be in effect at the date of system commissioning.

L. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.9 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Relative Humidity: 0 to 95 percent.

2. Altitude: Sea level to 1000 feet (300 m).

1.10 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: two (2) years from date of Substantial Completion.

1.12 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cummins Power Generation.

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.

2. Output Connections: Three-phase, four-wire.

3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

4. Furnish a coordinated assembly of compatible components.

5. Ratings: Voltage and power output ratings of system shall be as indicated. Frequency shall match utility service frequency unless otherwise indicated. Unit shall supply its indicated KW power load at power factors down to 80 percent.

6. Safety Standard: Comply with ASME B15.1.

7. Limiting dimensions indicated for system components shall not be exceeded.

8. Emissions and Noise: Emissions and Noise shall be in compliance with all applicable criteria regarding environmental pollution of all agencies having jurisdiction.

9. Skid: Adequate strength and rigidity to maintain alignment of mounted components without dependence on a concrete foundation. Skid shall be free from sharp edges and corners. Lifting attachments shall be arranged to facilitate lifting with slings without damaging any components.

10. The engine-generator set(s) , including radiator, shall be provided with a structural steel base. The base shall have sufficient rigidity for spring type isolators in quantities as required between enclosure floor and generator. Mounting shall incorporate a leveling device, vertical stops and three layers of neoprene acoustical pad, with each layer separated by a steel plate. The mountings shall be installed directly under the structural steel base and positioned to accept the weight and weight distribution for uniform mounting deflection. Spring isolators shall provide a minimum static deflection of 2 inches (5 cm) and shall be similar to Mason Industries, Inc., Type SLR or as approved. Neoprene pads shall be similar to Mason Industries Type W, or as approved.

11. Size and weight: Unit size and weight shall not exceed the following:

Weight of Unit and enclosure. (Ready to Run)	18,000 lbs.
Overall Length of Unit and enclosure.	18’-6”
Overall Width of Unit and enclosure.	7’-2”
Overall Height of Unit and enclosure.	8’-8”

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.

2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds. Unit shall accept a one-step application of 100 percent of specified load rating without causing the engine to stall.

3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.

4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.

6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

8. Temperature Rise of Generator: Not more than 105 deg C over a 40 deg C ambient, as measured by resistance, NEMA MG 1 when operating continuously at full-rated load.

9. Start Time: Comply with NFPA 110, Type 10, system requirements. Maximum total time period for a cold start, with ambient temperature at low end of specified range, shall be 8 seconds. Time period shall include output voltage and frequency settlement within specified steady-state bands.

2.3 ENGINE

A. Fuel: Diesel-fuel oil, Grade DF-2.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).

D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.

2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.

3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

4. Oil Cooler: Maintains lubricating oil at manufacturer's recommended optimum temperature.

E. Engine Fuel System:

1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.

2. Integral Injection Pumps: Driven by engine camshaft. Pumps shall be adjustable for timing and cylinder pressure balancing.

3. Fuel Oil Filters: Primary and secondary. Primary filter shall include water separator.

4. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

5. Integrally mounted, electric motor driven, air cooled fuel oil cooler, complete with electric supply tapped from generator control panel. Radiator cooled unit will not be acceptable unless manufacturer certifies that radiator has been sized to accommodate this additional load. Cooler shall limit maximum engine fuel inlet temperature with engine running continuously at full load as required by engine manufacturer.

6. Engine Ignition System: Energized from the engine battery or magnetic ignition system arranged to be switched on automatically in response to the external cranking circuit.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

G. Governor: Adjustable electronic isochronous type, with speed droop provisions.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

2. Radiator: Rated for specified coolant. Airflow shall be less than 100 CFM (170 cubic meters per hour) per kilowatt of certified load.

3. Radiator Core Tubes: Nonferrous-metal construction other than aluminum.

4. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

6. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.

b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

I. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

J. Starting System: 24-V electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.

2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.

3. Cranking Cycle: As required by NFPA 110 level 1.

4. Battery: Lead acid nickel cadmium with adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least three times without recharging.

5. Battery Cable: Size as recommended by engine manufacturer for cable length. Include required interconnecting conductors and connection accessories.

6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.

7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.

    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel and a dry contact closure for connection to BMS.

    f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30 and NFPA 37, and the requirements of local jurisdiction.

B. Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:

1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank. Epoxy coated interior, oil resistant enamel exterior finish.

a. Leak Detector: Locate in rupture basin. Dry contact closure for connection to fuel oil management control panel, plus additional dry contact closure for connection to BMS system, in the event of a day-tank leak. Switch shall be sealed against vapors and fluids, be lever float operated, and magnetically actuated. Wiring enclosure shall be cast aluminum NEMA 4 construction.

2. Tank Capacity: provide a 270 gallon sub-base tank.

3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.

4. Unit, including Pump Control Float and Alarm Contacts: Comply with UL 142.

5. Pump Control Float Contacts: Activates pump at 50 percent of normal fuel capacity and deactivates pump at 80 percent of normal fuel capacity.

6. Secondary Pump Control Float Contacts: Activates secondary pump plus dry contact closure for connection to fuel oil management control panel at 40 percent of normal fuel capacity.

7. Low-Level Alarm Sensor: Separate device shall operate dry contact closure for connection to fuel oil management control panel at 20 percent of normal fuel capacity.

8. High-Level Alarm Sensor: Separate device shall operate dry contact closure for connection to fuel oil management control panel and redundant fuel shutoff contacts at 90 percent of normal fuel capacity. Shutoff also shall close a solenoid valve in fuel suction line from fuel storage tank to day tank. Both items shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to fuel oil management control panel plus dry contact closure for connection to BMS but shall not shut down engine generator set.

9. Control Probe: Suitable for pressures to 150 psi (1000 kPa). Constructed entirely of non-ferrous material. Electrical connections shall be external to tank in cast aluminum NEMA 4 enclosure.

10. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.

C. Base-Mounted Fuel Oil Tank: Factory installed and piped, UL 142 fuel oil tank. Features include the following:

1. Tank level indicator.

2. Capacity: 270 gallon sub-base tank.

3. Vandal-resistant fill cap.

4. Containment Provisions: Comply with requirements of authorities having jurisdiction.

5. Double walled tank with integral leak detection with dry contact closure for connection to BMS.

6. Tank shall be vented to the outside of the enclosure with a minimum of a two-inch pipe with appropriate ball plunger type apparatus that will only allow fumes to be released to the atmosphere and not liquids.

D. Interior Fuel Oil Piping: Include required field installed piping between the day tank and the engine. Refer to Division 23 specifications for materials and installation.

2.5 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:

1. AC voltmeter.

2. AC ammeter.

3. AC frequency meter.

4. DC voltmeter (alternator battery charging).

5. Engine-coolant temperature gage.

6. Engine lubricating-oil pressure gage.

7. Running-time meter.

8. Ammeter-voltmeter, phase-selector switch(es).

9. Generator-voltage adjusting rheostat.

10. Fuel tank derangement alarm.

11. Fuel tank high-level shutdown of fuel supply alarm.

D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

E. Connection to Data Link: A Mod-Bus compatible interface for all monitoring and alarm functions. Also provide a separate terminal block, factory wired to Form "C" dry contacts, for each alarm and status indication for connections for data link transmission of indications to remote data terminals.

F. Supervision of control wiring to transfer switches (engine start).

G. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.

2. Coolant low-temperature alarm.

3. Control switch not in auto position.

4. Battery-charger malfunction alarm.

5. Battery low-voltage alarm.

6. Engine high-temperature shutdown.

7. Lube-oil, low-pressure shutdown.

8. Overspeed shutdown.

9. Remote emergency-stop shutdown.

10. Engine high-temperature prealarm.

11. Lube-oil, low-pressure prealarm.

12. Fuel tank low level.

13. Low coolant level.

H. Remote Alarm Annunciator: An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated. Include manual hand-Off-Auto control switch to control operation of generator. Install at fire command center or location as directed, complete with all required circuitry.

I. Remote Emergency-Stop Switch: Multipole emergency generator break-glass switch, in NEMA 3R enclosure located at the exterior of the generator enclosure at strike side of the main door. Provide nameplate to read "Emergency Generator Emergency Shutdown and Stop of Fuel Oil Flow". Activation of break-glass switch to shut down fuel supply to the engine and day tank with spare dry contact for connection to BMS. Install complete with circuitry.

J. Overcurrent protective devices: Generator overcurrent devices and other indicated components shall be grouped in a separately mounted generator power panel. Devices serving “Emergency” System and “Legally Required Standby System” loads shall be fully coordinated with downstream devices and shall be switch and fuse type if required in order to achieve this coordination. Other devices shall be circuit breaker type. Panel features shall include:

1. Switchboard type construction, with the devices serving emergency, legally required, and optional loads mounted in separate vertical sections.

2. Generator Circuit Breakers: Molded case or insulated case type conforming to Division 26 Section "Selection of Overcurrent Devices" with suitable interrupting capacity.

    a. Feeder Overcurrent Devices: with ratings as indicated on drawings. Instantaneous trip settings shall be adjustable.

    b. Load Bank Circuit Breakers: Main 3-pole circuit breaker sized at not less than 125 percent of resistor bank full load rating.

3. Generator Switch and Fuse Devices: Fusible switching devices conforming to Division 26 Section "Selection of Overcurrent Devices" with suitable interrupting capacity.

    a. Feeder Overcurrent Devices: with ratings as indicated on drawings.

K. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

L. Ground-Fault Protection shall be provided for overcurrent devices 800A or more which supply optional standby loads.

2.6 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Excitation shall use no slip or collector rings, or brushes, and shall be arranged to sustain generator output under short-circuit conditions as specified.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. The generator together with its associated voltage regulator, exciter, instrumentation, and controls shall be of a type that shall be suitable for applications where the load to be supplied consists of substantial amounts of non-linear (i.e., harmonic producing) equipment. Isolation transformers, complete with filtering equipment, shall be provided to minimize the effect of distortion on the voltage regulator power supply and sensing circuits, on governor control and supply circuits, on instrumentation and relaying and on other voltage sensing components. Voltage and current sensing devices shall sense true RMS values, and frequency sensing devices shall sense zero crossover.

J. Excitation System: Generator shall be equipped with a permanent magnet generator excitation system. The output of the PMG shall be used to supply power to the voltage regulator and to effectively isolate the regulator power circuits from the distortion that occurs when the generator supplies large non-linear loads. Under short circuit conditions, system shall be capable of sustaining 300 percent of rated current for 10 seconds. Rotating rectifier shall use a three-phase full wave rectifier assembly with hermetically sealed silicon diodes protected against abnormal transient conditions by a surge protector.

K. Voltage Regulator: Completely solid state with electronic components encapsulated for protection against vibration and atmospheric deterioration. The regulator includes three phase RMS sensing, true volts per hertz operation with adjustable cut in, and provisions for parallel operation.

1. A voltage adjusting rheostat shall be provided on the control panel to permit a plus or minus 10 percent adjustment in generator voltage.

2. The voltage regulator also includes circuits that provide loss of sensing voltage shutdown and overexcitation shutdown with inverse time characteristic to protect the generator and the connected load from abnormal voltages. Loss of sensing shutdown does not activate if a short circuit condition were to occur.

L. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

M. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

N. Subtransient Reactance: 12 percent, maximum.

2.7 LOAD BANK

A. Description: Permanent, weatherproof, remote-controlled, forced-air-cooled, resistive unit in NEMA 3R enclosure intended for outdoor mounting.

B. Unit capable of providing a balanced 3-phase, delta-connected load to generator set at 100 percent rated-system capacity. Unit shall be capable of selective control of load in 25 percent steps and with minimum step changes of approximately 5 and 10 percent available.

C. Resistive Load Elements: Corrosion-resistant chromium alloy with ceramic and steel supports. Elements shall be double insulated and designed for repetitive on-off cycling. Elements shall be mounted in removable aluminized-steel heater cases.

D. Load-Bank Heat Dissipation: Airflow and coil operating current shall be such that, at maximum load, with ambient temperature at the upper end of specified range, load-bank elements operate at not more than 50 percent of maximum continuous temperature rating of resistance elements.

E. Load Element Switching: Remote-controlled contactors switch groups of load elements. Contactor coils are rated 120 V. Contactors shall be located in a separate NEMA 250, Type 3R enclosure within load-bank enclosure, accessible from exterior through hinged doors with tumbler locks.

F. Contactor Enclosures: Heated by thermostatically controlled strip heaters to prevent condensation.

G. Protective Devices: Power input circuits to load banks shall be fused, and fuses shall be selected to coordinate with generator circuit breaker. Fuse blocks shall be located in contactor enclosure. Cooling airflow and over-temperature sensors shall automatically shut down and lock out load bank until manually reset. Safety interlocks on access panels and doors shall disconnect load power, control, and heater circuits. Fan motor shall be separately protected by overload and short-circuit devices. Short-circuit devices shall be non-interchangeable fuses with 200,000-Ampere interrupting capacity.

H. Load-Bank Enclosures: NEMA 250, Type 3R, complying with NEMA ICS 6. Louvers at cooling-air intake and discharge openings shall prevent entry of rain and snow. Openings for airflow shall be screened with 1/2-inch- (13-mm-) square, galvanized-steel mesh. Forced air cooling system incorporating motor driven centrifugal fan with combination motor starter and automatic start control, fan failure, high exhaust temperature and high intake temperature alarms and resistor shutdown circuitry.

I. Automatic Control System: Incorporates the following features and functions:

1. An integral "generator voltage" sensing circuit arranged to delay the initial application of the first and second stages of the load bank until rated generator voltage is sensed for a time (field adjustable from 0 to 10 seconds). Voltage shall be sensed at the load bank itself.

2. A load bank cool-down circuit arranged to keep the cooling fan running for an adjustable period (0-10 minutes) after generator shutdown.

3. The third and fourth stages of resistance shall be instantaneously applied in two steps when the downstream sensor senses reverse power of 10 KW and 50 KW respectively. The sensing circuit incorporates field adjustable instantaneous "pickup" settings, and field adjustable "dropout" settings and "off" time delays.

4. The time delay relays utilized to delay the initial application of the first and second resistance stages shall be bypassed in the event that the reverse power continues to rise above 50 KW. The bypass feature causes the first and second stages to be instantaneously applied (if they have not already been applied on a time delayed basis) in two steps when reverse power of 90 KW and 130 KW respectively is sensed.

5. The sensing devices shall be of an RMS reading type (equipped with filtering and isolation if required) that will not be affected by the distorted wave shape produced by SCR power supplies constituting a major portion of the load applied to the generator.

J. Remote-Control Panel: Separate from load bank in NEMA 250, Type 1 enclosure with a control power switch and pilot light, and switches controlling groups of load elements.

K. Control Sequence: Control panel may be preset for adjustable single-step loading of generator during automatic exercising.

2.8 OUTDOOR GENERATOR SET ENCLOSURE WRAP-AROUND (I.E., NON WALK-IN) TYPE

A. Description: Weatherproof non-walk-in type sound attenuating enclosure, mated and matched to the unit enclosed so as to permit proper cooling and to afford ready access to all control, inspection and servicing points. Enclosure shall limit the sound as required to comply with applicable sound restrictions, but in any case, to no more than 80 dBA as measured at 5 feet (90 cm) from any side, top or bottom, under all operating conditions. Appropriate sound baffling and insulation shall be applied to achieve this designated sound level.

B. Construction: Rust-resistant, complying with the following:

1. Enclosure and other items shall be designed and built by the engine manufacturer as an integral part of the engine generator set and shall be designed to perform without overheating in the ambient temperature specified.

2. Enclosure shall be constructed of 14-gauge and 16-gauge sheet metal, suitably reinforced to be vibration free in the operating mode.

3. Doors provide access for service. Each door shall have at least one latch-bearing point.

4. Provide stairs complete with platforms, railings, and handrails as required to provide full access to each service access door. They shall be steel, hot-dipped galvanized after fabrication, and shall comply with the requirements of Division 5, Miscellaneous Metals. They shall comply with the applicable building codes, OSHA standards, State Occupational Safety and Health Plan requirements, and other applicable regulations.

5. Side and rear panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools.

6. Finish shall be baked enamel with primer and finish coat painted before assembly. Fasteners shall be rust resistant.

7. Unit shall have sufficient guards to prevent entrance by small animals.

8. Batteries shall fit inside enclosure and alongside the engine.

9. Unit shall have coolant and oil drains outside the unit to facilitate maintenance. Each drain line shall have a high quality valve located near the fluid source.

10. Fuel filter shall be inside the base perimeter and located so spilled fuel cannot fall on hot parts of engine or generator. A cleanable primary fuel strainer shall be provided to collect water and sediment between tank and main engine fuel filter.

11. Crankcase fumes disposal shall terminate in front of the radiator to prevent oil from collecting on the radiator core and reducing cooling capacity.

12. Enclosure shall house batteries, fuel tank, fuel pump, lighting, lighting switch, heaters, battery charger, and accessories to provide a self-contained operating unit.

13. Enclosure shall include two space heaters complete with thermostat, sized as required to maintain a minimum housing interior temperature of 40 deg F (5 deg C).

14. Louvered air openings shall have motorized shutters, controls and screens. Shutter operation shall be fail-safe. Under no conditions shall the shutters fail in the shut position with the generator running.

15. The muffler shall be contained within the housing. Exhaust pipe shall extend through the housing and shall be fitted with a rain cap.

C. The generator day tank shall be vented to the outside of the enclosure with a minimum of a 2 inch (5 cm) pipe with appropriate ball plunger type apparatus that will only allow fumes to be released to the atmosphere and not liquids.

D. Fuel supply and return shall terminate at the enclosure wall. Supply line shall also be equipped with shutoff valve for unit isolation solenoid valve for unit operation. The fuel oil return line shall be equipped with a check valve as a prevention from loss of prime as well as a gate valve for unit isolation. Both supply and return piping shall be equipped with stainless steel flexible connections. Fuel oil pipe shall be black seamless steel A53 Schedule 40 with malleable iron fittings.

2.9 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Bridge-bearing neoprene, complying with AASHTO M 251.

2. Durometer Rating: As recommended by manufacturer for the load.

3. Number of Layers: As recommended by manufacturer for the load. Multiple layers shall be separated by steel shims.

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.11 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set, and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.

2. Full load run.

3. Maximum power.

4. Voltage regulation.

5. Transient and steady-state governing.

6. Single-step load pickup.

7. Safety shutdown.

8. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install generator set(s) , load banks, and other components as indicated, in accordance with equipment manufacturers written instructions, and with recognized industry practices, to ensure proper performance in accordance with the specifications. Comply with applicable NEMA standards pertaining to installation of engine-generator sets and accessories and with NFPA110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch (25 mm) on 4-inch- (100-mm-) high concrete base. Secure sets to anchor bolts installed in concrete bases.

D. Include the installation of control and monitoring panels, battery charger(s), remote annunciator panel, day tank(s), batteries and racks, and other appurtenances to the extent that such appurtenances are not factory installed and wired including, piping between engine and day tank.

E. Include field interwiring and power supply and control connections for load bank, batteries, battery chargers, pumps, heaters, float switches, solenoid valves, damper operators and other miscellaneous items as required in accordance with manufacturers wiring diagrams. Such wiring includes (but is not limited to):

1. Wiring between battery and engine control panel(s) and battery charger(s).

2. Power supply wiring from an appliance panel to battery charger.

3. Power supply wiring from an appliance panel and control wiring for engine jacket water heater(s).

4. Power supply wiring for fuel pumps and fuel management control panel.

5. Control wiring for fuel pumps, fuel tanks, day tanks, float switches, valves, leak detection system, and other fuel supply system components.

6. Power supply and control wiring for automatic louver damper operators.

7. Emergency stop break glass switch and control wiring run to engine control panel.

8. "Manual start" switch located in Fire Command Center and control wiring to engine control panel.

9. Remote annunciator panel mounted where indicated or where directed, complete with power supply and alarm interwiring to engine control panel.

F. Ground equipment in accordance with Division 26 Section "Grounding and Bonding".

G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

H. Include the installation of the load bank, complete with all required power, control, sensing and devices as required to comply with the functional requirements of Part 2 of this Section. Circuitry and devices include - but are not limited to - the following:

1. Power circuit connection from generator output circuit breaker. Conductors shall be sized to match circuit breaker trip rating and shall be run in conduit.

2. Control power supply conductors run in conduit from a 3-pole circuit incorporated as part of a "hot" emergency panel (i.e., panel connected to load side of an ATS).

3. Load sensing circuitry extension run in conduit from generator current transformers to load bank control panel.

4. "Normal" power sensing circuitry run in conduit from each ATS to load bank control panel.

5. Three phase "generator voltage" sensing circuitry run from generator output OCD to load bank control panel.

6. "Remote" control panel circuitry extension in conduit to load bank control panel.

7. Any interwiring necessitated by a load bank configuration that separates out equipment items indicated as being integrally mounted.

I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect cooling-system water piping to engine-generator set and remote radiator with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. Connect fuel piping to engines with a gate valve and union and flexible connector.

1. Natural-gas piping, valves, and specialties for gas distribution are specified in Section 23 11 23 "Facility Natural-Gas Piping."

F. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 IDENTIFICATION

A. Identify system components according to Section 23 05 53 "Identification for HVAC Piping and Equipment" and Section 26 05 53 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.

C. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test, and a final acceptance test of a completed system by opening building’s main service switches or circuit breakers.

3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.

b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.

c. Verify acceptance of charge for each element of the battery after discharge.

d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.

6. Exhaust Emissions Test: Comply with applicable government test criteria. Provide necessary test results to permit the registration of the generator with local authorities.

7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases and verify that performance is as specified.

8. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

9. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

D. Coordinate tests with tests for transfer switches and run them concurrently.

E. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

F. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

I. Remove and replace malfunctioning units and retest as specified above.

J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

L. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 26 32 13

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SECTION 26 36 00 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes transfer switches rated 600 V and less, including the following:

1. Bypass/isolation switches.

2. Remote annunciation systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.

2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain, bypass/isolation switches, and remote annunciators through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA ICS 1.

F. Comply with NFPA 70 as amended by state and local codes.

G. Comply with NFPA 110.

H. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."

PART 2 - PRODUCTS

2.1 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.

2. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Switching. Switch shall be of the 4-pole type when interposed in a 4-wire feeder, regardless of any other indication to the contrary. Neutral pole shall be switched simultaneously with phase poles.

H. Neutral Terminal: Ampacity and switch rating of neutral path shall be equal to the rating of the switch, unless otherwise indicated.

I. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for installation in feeder with oversize neutral shall be double the nominal rating of the circuit in which the switch is installed.

J. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

K. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Section 26 05 53 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.

3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

L. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated. Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

2.2 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source and a second set that operates in advance of transfer to the emergency source. Interval shall be adjustable from 1 to 30 seconds.

E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. Transfer Switches Based on Molded-Case-Switch Components: Comply with NEMA AB 1, UL 489, and UL 869A.

G. Automatic Closed-Transition Transfer Switches: Include the following functions and characteristics:

1. Fully automatic make-before-break operation.

2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.

3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.

    a. Initiation occurs without active control of generator.

    b. Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.

4. Failure of power source serving load initiates automatic break-before-make transfer.

H. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.

3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

5. Test Switch: Simulate normal-source failure.

6. Switch-Position Pilot Lights: Indicate source to which load is connected.

7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Four normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.

11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.

    b. Push-button programming control with digital display of settings.

    c. Integral battery operation of time switch when normal control power is not available.

2.3 BYPASS/ISOLATION SWITCHES

A. Each automatic transfer switch shall be provided with bypass/isolation capacity.

B. Comply with requirements for Level 1 equipment according to NFPA 110.

C. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:

1. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.

2. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations.

3. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.

4. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.

5. Operability: Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.

6. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.

7. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

D. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

2.4 REMOTE ANNUNCIATOR AND CONTROL SYSTEM

A. Functional Description: Include the following functions for indicated transfer switches:

1. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.

2. Indication of switch position.

3. Indication of switch in test mode.

4. Indication of failure of digital communication link.

5. Key-switch or user-code access to control functions of panel.

6. Control of switch-test initiation.

B. Malfunction of communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.

2.5 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated. Construct concrete bases according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

B. Identify components according to Section 26 05 53 "Identification for Electrical Systems."

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

1. For automatic transfer switch(es) include 4 #14 THWN control circuit run in conduit from switch(es) to emergency generator starting and shutdown devices at engine generator control gear. Connect as required.

2. For automatic transfer switch(es) include 2 #14 voltage sensing circuit run in conduit from switch(es) to Building Management System panel to sense "emergency power." Terminate in outlet box with slack conductors (for extension by others) at panel. Connect to voltage sensing contact at ATS.

3. Provide 2-hour rated for control circuits between fire pump automatic transfer switch and generator.

B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.

b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.

c. Verify that manual transfer warnings are properly placed.

d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.

b. Simulate loss of phase-to-ground voltage for each phase of normal source.

c. Verify time-delay settings.

d. Verify pickup and dropout voltages by data readout or inspection of control settings.

e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Section 01 79 00 "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION 26 36 00

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SECTION 26 41 13 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes lightning protection for buildings and associated structures and requirements for lightning protection system components.

B. System protects entire building and outlying electro/mechanical equipment.

1.3 ACTION SUBMITTALS

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

B. Shop Drawings: For air terminals and mounting accessories.

1. Layout of the lightning protection system, along with details of the components to be used in the installation.

2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.

B. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.

C. Field quality-control reports.

D. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.

E. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:

1. Ground rods.

2. Ground loop conductor.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Certified by UL, trained and approved for installation of units required for this Project.

B. System Certificate:

1. UL Master Label.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.6 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96 and NFPA 780.

B. Roof-Mounted Air Terminals: NFPA 780, copper unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Heary Bros. Lightning Protection Co. Inc. (Basis of Design)

b. Approved Lightning Co.

c. Associated Lightning Rod Co.

d. East Coast Lightning Equipment Inc.

e. ERICO International Corporation.

f. Harger.

g. Independent Protection Co.

h. Preferred Lightning Protection.

i. Robbins Lightning, Inc.

j. Thompson Lightning Protection, Inc.

2. Air Terminals More than 24 Inches (600 mm) Long: With brace attached to the terminal at not less than half the height of the terminal.

3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in roofing Sections.

C. Main and Bonding Conductors: Copper unless otherwise indicated.

D. Ground Loop Conductor: The same size and type as the main conductor except tinned.

E. Ground Rods: Copper-clad steel; 3/4 inch (19 mm) in diameter by 10 feet (3 m) long.

2.2 SURGE SUPPRESSION

A. Provide surge protection on the electrical, telephone, and antenna and TV lead wires. The surge suppressor for the main electrical panel shall be industrial grade, with field replaceable modules and indicator lights. The suppressor shall have multiple surge paths per phase. The electrical surge suppression equipment shall be installed at the main entrance of the electrical system with a disconnecting mechanism. The surge suppressor shall have the capability of being disconnected without shutting down the electrical system. Telephone surge suppression shall be to the standards of the telephone system carrier. The suppressor shall be industrial grade with replaceable modules, and a reaction time of less than one (1) nanosecond. This surge equipment shall be installed at the main entrance of the telephone system.

B. Antenna and TV lead wire suppressors shall be industrial grade suitable for the conductor, coax or hard wire. The suppressor shall have a reaction time of less than one (1) nanosecond and shall be installed as close to the antenna or TV camera as possible.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.

C. Conceal the following conductors:

1. Down conductors.

2. Interior conductors.

3. Conductors within normal view of exterior locations at grade within 200 feet (60 m) of building.

D. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.

1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.

E. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

F. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to lightning protection components.

G. Bond grounded metal bodies on building within 12 feet (4 m) of ground to counterpoise conductor.

H. Bond grounded metal bodies on building within 12 feet (4 m) of roof to counterpoise conductor.

I. Bond grounded metal bodies on building within 12 feet (4 m) of roof to interconnecting loop at eave level or above.

J. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of structure and other protected items.

1. Bury ground ring not less than 24 inches (600 mm) from building foundation.

2. Bond ground terminals to the ground loop.

3. Bond grounded building systems to the ground loop conductor within 12 feet (3.6 m) of grade level.

3.2 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

B. UL Inspection: Meet requirements to obtain a UL Master Label for system. Apply for inspection by UL as required for UL master labeling of system. Provide additional components as required to obtain UL Master Label at no additional cost to owner.

END OF SECTION 26 41 13

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SECTION 26 43 13 - SURGE PROTECTIVE DEVICES (SPDs)

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section includes the following basic electrical materials and methods to complement other Division 26 Sections.

B. This Section includes surge protective devices for low-voltage power, control, and communication equipment.

C. Related Sections include the following:

1. Division 26 Section "Switchboards" for factory-installed surge suppression devices.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

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

1. Section 26 05 00 “Common Work Results for Electrical”.

2. This section is a part of each Division 26.

1.3 DEFINITIONS

A. I Nominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

B. Product Certificates: Signed by manufacturers of surge protective devices, certifying that products furnished comply with the following testing and labeling requirements:

1. UL 1283 certification.

2. UL 1449, Fourth Edition listing and classification.

C. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Failed test results and corrective action taken to achieve requirements.

D. Maintenance Data: Surge protective devices to include maintenance manuals specified in Division 01.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. IEEE Compliance: Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide for Surge Suppressor Testing."

D. UL Compliance: Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, Third Edition "Surge Protective Devices."

E. Comply with NFPA 70, Article 285, as amended by state and local codes.

F. UL 96A Lighting Protection Master Label compliant.

1.6 PROJECT CONDITIONS

A. Placing into Service: Do not energize or connect service entrance equipment to their sources until the surge protective devices are installed and connected.

B. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage. The maximum value shall be a tested value as part of the nominal discharge surge current test.

2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).

3. Humidity: 0 to 85 percent, noncondensing.

4. Altitude: Less than 20,000 feet (6000 m) above sea level.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Current Technology; a brand of Thomas & Betts.

2. Cutler-Hammer, Inc. a division of Eaton Corp.

3. Mersen USA.

4. Siemens Energy & Automation.

5. Square D, a brand of Schneider Electric.

2.2 SERVICE ENTRANCE SUPPRESSORS

A. Surge Protective Device Description: Non-modular type with the following features and accessories:

1. Type 1 SPD, 20kA nominal discharge current rating.

2. LED indicator lights for power and protection status.

3. Audible alarm, with silencing switch, to indicate when protection has failed.

4. One set of dry contacts rated at 5 A, 250-V AC, for remote monitoring of protection status.

5. Fuses, rated at 200-kA interrupting capacity.

B. Connection Means: Permanently wired to a fused disconnect switch.

C. Protection modes and UL 1449 Voltage Protective Rating (VPR) for grounded wye circuits with voltages of 480Y/277; 3-phase, 4-wire circuits, are as follows:

1. Line to Neutral: 1200 V for 480Y/277.

2. Line to Ground: 1200 V for 480Y/277.

3. Line to Line: 2000 V for 480Y/277.

4. Neutral to Ground: 700 V for 480Y/277.

2.3 CONTROL AND DATA TERMINALS

A. Protectors for copper control data telephone conductors entering the building from the outside are as recommended by the manufacturer for the type of line being protected.

2.4 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected, unless factory - installed within equipment enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES

A. Locate and install devices at service entrance on line or load side of largest service switch, with ground lead bonded to service entrance ground.

B. Locate and install devices at all emergency switchboards or switchgear, and at all emergency panelboards

C. Install devices for panelboards with conductors between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide multipole, overcurrent protective device as a dedicated disconnect for the suppressor, unless otherwise indicated. Follow applicable installation instructions from the SPD manufacturer.

D. Locate and install devices at fire pump controllers.

3.2 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.3 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing:

1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements.

2. Complete startup checks according to manufacturer's written instructions.

3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.

B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

END OF SECTION 26 43 13

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SECTION 26 50 10 – SPECIALTY LIGHTING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 01, General Requirements, shall be included in, and made part of, this Section.

B. Where conflicts in specification requirements between this section and others exist the most stringent requirements shall apply.

1.2 DESCRIPTION OF WORK

A. The work of this Section shall include furnishing and installation of all interior and exterior lighting fixtures and necessary supports and devices for a complete functioning lighting system; including final aiming and adjustment as applicable in coordination with the Architect and/or the Lighting Designer.

B. The work under this Contract shall also include all labor, materials, tools, equipment, transportation, insurance, temporary protection, supervision and incidental items essential for proper installation and operation, even though not specifically mentioned or indicated on the drawings, but which are usually provided or are essential for proper installation and operation of all systems as indicated on the drawings and specified herein.

C. The specifications and drawings describe the minimum requirements that must be met by the Contractor for the installation of all work as shown on the drawings and as specified herein under.

D. The following general systems and equipment shall be provided for the project, as a minimum, but not necessarily limited to the following:

1. Lighting fixtures

2. Lamps/Light Sources

3. Drivers

1.3 RELATED WORK

A. For work to be included as part of this Section, to be furnished and installed by the Contractor, refer to the Related Work section of Specification Section 260510.

B. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.

1.4 REFERENCES

A. All lighting fixtures including custom fixtures and modified standard products shall comply with all applicable provisions of the following Codes and Trade Standard Publications, and are hereby incorporated into, and made a part of, the Contract Documents:

1.	ANSI:	American National Standards Institute
2.	ASTM:	American Society for Testing and Materials
3.	ETL:	Electrical Testing Labs (US)
4.	FS	Federal Specifications
5.	IEC IP Rating:	Ingress Protection Enclosure Ratings and Standards
6.	IEEE:	Institute of Electrical and Electronics Engineers
7.	IES:	Illuminating Engineering Society
8.	IPCEA:	Insulated Power Cable Engineers Association
9.	MIL-STD-461F	EMI Characteristics Requirements for Equipment
10.	NEC:	National Electrical Code
11.	NEMA:	National Electrical Manufacturers Association
12.	NFPA 70:	National Electrical Code
13.	OSHA:	Occupational Safety and Health Administration
14.	ROHS	Restriction of Hazardous Substances in LED
15.	UL:	Underwriters' Laboratories

1.5 QUALITY ASSURANCE

A. The manufacturers listed within the Lighting Fixture Schedule have been preselected for use on this project. No submittal will be accepted from a manufacturer other than specified.

B. Contractor Responsibilities: Confirming quantities, coordinating work of other trades, performing work safely, storage of materials prior to installation.

1.6 WARRANTY

A. In addition to the provisions of the General Requirements, Supplementary General Requirements and Section 260510 regarding guarantees and warranties for the work under this Contract, lighting fixture manufacturer(s) shall provide a total system warranty that includes the fixture, lamps, ballasts and all associated wiring and appurtenances provided with each fixture.

B. For a period of one year after Owner's initial acceptance and establishment of the beginning date of the warranty period, and at no additional cost, promptly provide and install replacements for fixtures or components which, in the opinion of the Owner, are defective in materials or workmanship under normal operating conditions. If approved to do so by the Owner, repair installed equipment at the job site to Owner's satisfaction, provided that the Contractor repairs any damage to adjacent Work. For any time during the warranty period that fixtures are not fully functional due to defects in materials or workmanship, provide or pay for and install and remove suitable and adequate temporary lighting fixtures. All replacement fixtures or components shall be warranted to be free of defects in workmanship or materials for a period of one year following the replacement. The Contractor shall replace any defective replacements during their warranty period.

1.7 BASE BID

A. The base bid lighting fixtures that are specified in the Lighting Fixture Schedule by manufacturer and model numbers represent the standard for photometric performance, energy efficiency, aesthetics, physical dimensions, finishes, materials and construction integrity. Equal products from the list of approved alternate manufacturers, submitted for pre-approval prior to end of the bidding phase may be submitted in lieu of the specified standard.

B. Contractor shall supply ‘contractor net’ unit pricing for each specified lighting fixture type. Unit pricing shall be for equipment only and not include installation or miscellaneous electrical costs. The unit price supplied shall be guaranteed for the project and remain valid for additions and/or deletions of the fixture throughout the duration of the project.

C. Within ninety (90) days of contract award, the successful Contractor shall issue to the Architect a complete list of lighting products submittals, including manufacturer model numbers, catalog cuts and photometric testing information.

D. Should the Contractor anticipate that the delivery schedule of any specified product may adversely impact the construction schedule, it shall be brought to the Architect’s and the Lighting Designer’s attention at the time of bidding.

1.8 APPROVED LIGHTING FIXTURE MANUFACTURERS

A. Alternate products other than those listed in the Lighting Fixture Schedule will not be considered as a substitution unless specified products are no longer available. Voluntary product substitution(s) will not be considered.

1. Final determination of alternate manufacturers/products' compliance with the base bid standard shall be made solely by the Architect and Lighting Designer.

2. The Lighting Designer reserves the right to request additional information, testing and working samples to determine that the submitted alternates comply with the base bid standards.

B. If a substitution of materials or products in whole or in part is made, the Contractor shall bear the cost of any changes in the work required by other trades as a result of the substitution.

1.9 SUBMITTALS

A. Prepare and submit shop drawings in accordance with the requirements hereinbefore specified, and with Section 01 3300 – Submittal Procedures in the manner described therein, modified as noted hereinafter.

B. If requested by the Architect and/or Lighting Designer, submittal for specified fixture types shall also include an operable non-returnable sample with 120 volt 72-inch grounded cord and plug with specified lamp color temperature and finish. All samples shall include a label describing fixture type, manufacturer catalog number, lamp color temperature, CRI index and lumen output.

C. Submit complete manufacturer's product data of all materials and systems to the Architect and the Lighting Designer for approval, consisting of complete product description and specifications, complete performance test data, complete preparation and installation instructions, and all other pertinent technical data required for complete product and product use information (.ies files and maintenance manual). The General and Electrical Contractor is to verify and coordinate all ceiling grid types and ceiling hanger types with fixture catalog numbers.

D. All shop drawings shall have clearly marked the fixture type, the appropriate specification number and/or drawing designation for identification of the submittal. Indicate on shop drawings, materials, finishes, metal gauges, overall and detail dimensions, sizes, electrical and mechanical connections, fasteners, welds, joints, end conditions, provisions for the work of others, and similar information. Include pertinent mounting details including hung ceiling construction. Indicate type and extent of approved inert insulating materials to prevent electrolytic corrosion at junctions of dissimilar metals shall be supplemented by additional drawings if information or descriptions listed above are not included in the cuts.

E. Submit independent laboratory photometric data in the required number of copies and in format as directed by the Architect or the Lighting Designer. Photometric data shall be submitted for standard, “off-the-shelf” units, at the time the manufacturer’s cuts are submitted. Photometric testing and reporting shall conform to IES procedures.

F. Manufacturer's Catalogue Sheets shall indicate input and load electrical characteristics, ambient temperature rating, noise level rating, mounting methods and UL listing.

G. LED fixture manufacturer shall submit, with fixture Shop Drawing or Catalogue Sheet the following information:

1. IESNA LM-79 and LM-80 test reports including, but not limited to, testing agency, report number, date, catalog number, type of equipment, LED source tested and ambient temperature, .ies format photometric files.

2. Certification that the manufacturer is in compliance with all standards and IESNA documentation.

3. Certification that the fixture meets recyclability requirements.

H. Disposition of shop drawings shall not relieve the Contractor from the responsibility for deviations from drawings or specifications unless he has submitted, in writing, a letter itemizing or calling attention to such deviations at time of submission and secured written approval from the Architect and the Lighting Designer, nor shall such disposition of shop drawings relieve the Contractor from responsibility for errors in shop drawings or schedules.

I. Shop drawings, samples, test data and certificates shall be submitted for approval in accordance with the requirements of the Contract Documents. Fixtures or other materials shall not be shipped, stored or installed into the work unless prior approval has been received, based upon the submittal of shop drawings, samples, catalogue cuts, test data, certificates or other materials submitted for approval. Make modifications to fixtures in accordance with the Architect's and the Lighting Designer’s comments concerning submittals, as a part of the work of this Section.

J. Submittal Schedule

1. Within 30 calendar days after award of General Contract, a List of Intended Manufacturers and estimated fabrication lead times shall be submitted to the Architect and the Lighting Designer. "Lead times" shall be measured in weeks, beginning from the manufacturer's receipt of approved shop drawings and release, and ending at shipment. The Architect and the Lighting Designer shall approve or disapprove each manufacturer.

2. Within 15 days after Contractor's receipt of the Architect's and the Lighting Designer’s response to the List of Intended Manufacturers, copies of purchase orders and manufacturers' acknowledgements for all fixtures specified, conforming to the Architect's and the Lighting Designer’s responses, shall be forwarded to the Architect and the Lighting Designer. The purchase orders and the manufacture acknowledgements need not list prices but shall contain a warranted fabrication lead time, in weeks, as defined above. These fabrication times shall be adequate for the timely completion of the job.

3. Within 30 days after date of manufacturer's acknowledgement of order, Contractor shall forward to the Architect and the Lighting Designer complete shop drawings, and/or catalogue cuts for all specified fixtures.

4. Within 15 days after receipt of reviewed shop drawings marked with "approved" or "approved as noted”, Contractor shall forward to the Architect and the Lighting Designer a warranted shipment date for each specified fixture, as well as forwarding samples, texts, or any outstanding data required for approval.

5. Within 15 days after Contractor's receipt of reviewed shop drawings marked with "revise and resubmit", revised shop drawings shall be resubmitted to the Architect and the Lighting Designer.

6. Contractor shall call to the attention of the Architect and the Lighting Designer any submittals that have not been returned to him in a timely manner and that might affect the appropriate delivery of fixtures.

1.10 COORDINATION

A. The work of this Section shall be coordinated with other work of the Contractor. The placement of all access panels shall be coordinated with all other Trades and with the Architect and the Lighting Designer.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide materials, equipment, appurtenances and workmanship for the work of this Section conforming to the highest commercial Standards as specified and indicated on the drawings. Make fixture parts and components not specifically identified or indicated on the drawings, of materials most appropriate to their use or function, and resistant to corrosion and to thermal and mechanical stresses encountered in the normal application and function of the fixtures.

B. Provide recessed fixtures that are constructed to be suitable for and compatible with the ceiling, wall, floor or pavement materials and construction in which they shall be installed.

2.2 MATERIALS AND FABRICATION

A. Provide fixtures, completely factory assembled, wired, and equipped with necessary sockets, ballasts, wiring, shielding, reflectors, channels, lenses and other parts and appurtenances necessary to complete the fixture installation and deliver to project site ready for installation.

2.3 FINISHES

A. Lighting fixture finishes shall be selected by the Architect and the Lighting Designer. The Architect and the Lighting Designer shall select finishes and indicate the color selections on the shop drawing submittals.

2.4 FIXTURE WIRING

A. Provide wiring channels and wireways free from projections and rough or sharp edges throughout. At points or edges over which conductors shall pass and may be subject to injury or wear, round bush to make a smooth contact surface with the conductors.

B. Install insulated bushings at points of entrance and exit of flexible wiring.

2.5 LED DRIVERS

A. Provide drivers for LED lamps that are suitable for the electrical characteristics of the supply circuits to which they are to be connected, and which are suitable for operating the specified lamps. Provide drivers which, unless specifically indicated otherwise or are not available for the specified lamp, have the following characteristics:

1. Constant Current/Voltage.

2. Power factor □ .90

3. Total harmonic distortion □ 20%

4. Lamp current crest factor □ 1.7

5. UL Class 2

6. Sound Rating A

7. NEMA 410 Compliant

B. Provide drivers conforming to UL and ANSI specifications and displaying labels or symbols of approval by the UL and of certification by the CBM. Design, fabricate and assemble component parts of drivers in accordance with the latest requirements of the NEC. Mark drivers "Class 2" indicating approved integral driver protection. This driver protection is provided by a built-in self-resetting thermally actuated device that will remove the driver from line when excessive driver temperature is reached.

C. Rigidly mount drivers, unless specifically indicated otherwise, to the inside of the top of the fixture housing, with driver surfaces and housing in complete contact for efficient conduction of driver heat. Permanently affix driver mounting screws to the fixture housing. Provide only fixtures whose design, fabrication, and assembly prevent overheating or cycling of lamps and drivers under any condition of use.

D. Dimming drivers shall be compatible with 0-10VDC, 3-wire (Line Voltage), Electronic Low Voltage (ELV) or Digital Addressing as required by lighting control vendor and fixture manufacturer. Provide identical drivers within each fixture type.

E. Provide drivers having the lowest sound-rating available for the lamps specified and clearly showing their respective sound ratings. Replace drivers found by the Architect or the Lighting Designer to be unduly noisy, without charge, prior to acceptance of the job. Inform the Architect and the Lighting Designer in writing if drivers with a sound rating other than A are to be provided.

F. For outdoor use and wherever drivers are used outside a heated environment provide drivers capable of lamp-starting at any temperature down to 0 degrees F.

G. Approved Driver Manufacturers

1. Philips Advance
2. General Electric
3. Hatch
4. Lutron
5. Sylvania (Osram)
6. Universal
7. Thomas Research
8. EldoLED

Or pre-approved equal.

H. Drivers shall have a 5-year warranty from date of acceptance of the completed installation.

2.6 LIGHT EMITTING DIODE ASSEMBLIES

A. These requirements refer to the LED assembly, including diodes, integrated circuit boards, lenses and remote-phosphor panels, heat sinks and assembly frames, and drivers or power supplies (if integrated with driver).

B. LED diode arrays, unless otherwise specified in the Lighting Fixture Schedule.

1. Shall be 3000°K correlated color temperature with a maximum 3-step MacAdam ellipse variation

2. CRI ≥ 80

3. Lamp life ≥ 50,000 hours, and maintain ≥ 70% of initial lamp lumen output throughout this period.

4. Have a minimum efficacy of 50 lumens per watt.

5. LED arrays shall meet all applicable IESNA and ANSI standards relating to measurement and construction in effect at their time of purchase.

C. Manufacturer shall provide LED arrays and components that comply with the criteria listed above and meet or exceed the current technology or standards at the time of production. 90 days prior to production, manufacturer shall provide re-submittal of specified fixtures documenting specific LED arrays to be installed that match the performance, specified color temperature, lumen output, photometric distribution and method of control. Any variance between the submitted fixture type and specified model shall be clearly documented by the Contractor and included with the fixture submittal.

D. All LED assemblies shall be covered by a (5) year full manufacturer's warranty covering the assembly and its replacement in case of failure, provided that operating conditions (thermal and electrical) are maintained within the manufacturer's stated limits.

E. For each LED fixture type, the vendor shall provide an IES formatted photometric performance analysis report by a recognized independent testing laboratory. Test procedures and data presentation shall be as per IESNA LM-79.

F. All LED assemblies shall be field replaceable with minimal labor and shall be maintainable without removal of the fixture housing from its location. The fixture manufacturer shall keep a record of the physical bin, color temperature, chromaticity and efficacy rating for each array series in order to provide future replacement units that match the originally furnished array in color and photometric performance.

G. For other fixtures, provide lamps as specified, or if not specified, as rated by the manufacturer. If specification is not complete, contact the Architect and the Lighting Designer for clarification.

H. The following LED lamp manufacturers are approved:

1. Cree
2. General Electric
3. Philips
4. Sylvania (Osram)
5. Nichia
6. Ushio
7. Venture
8. Xicato
9. Samsung

Or pre-approved equal.

2.7 LENSES/FACEPLATES/TRIM

A. Where plastic lenses are indicated provide lenses of virgin methyl methacrylate, unless otherwise indicated.

B. Make lenses, louvers or other light diffusing elements contained in frames removable, but positively held within the frames so that hinging or other motion of the frame shall not cause the diffusing element to drop out.

C. All recessed downlights in painted dry wall ceilings or acoustic tile ceilings shall have self-trimming reflectors with white flanges. All recessed downlights in perforated metal or wood ceilings shall have self-trimming reflectors in finishes as specified in the Lighting Fixture Schedule.

D. Refer to architectural plans to match trim styles. Coordinate trim styles with ceiling type.

2.8 EXTERIOR FIXTURES

A. Provide fixtures designed and manufactured specifically for outdoor service. Make components, including nuts, bolts, rivets, springs and similar parts of materials of effective corrosion resistance or of materials which have been subjected to finishing treatment which shall ensure such resistance.

B. Provide fixtures for use outdoors or in areas designated as damp locations which are suitably and effectively gasketed to prevent access of moisture into electrical components or enclosing diffusers, lenses or globes.

C. Provide metal parts of fixtures for use in outdoor or damp locations which are specified as requiring painting with suitable weather and moisture resisting qualities equal to epoxy-based coatings.

D. Provide anodized aluminum for aluminum parts of exterior fixtures which are not specified as requiring a painted finish.

E. Provide fixtures with a minimum IP65 rating for wet location outdoor conditions, effectively gasketed to prevent access of moisture into electrical components or enclosing diffusers, lenses or globes.

F. Provide marine grade finish fixtures, for locations with harsh exposure as required.

2.9 LIGHTING FIXTURES

A. Refer to lighting fixture schedule on the drawings and the lighting fixture cut sheets attached to the end of this section.

PART 3 - EXECUTION

3.1 COOPERATION AND WORK PROGRESS

A. The Electrical work shall be carried on under the usual construction conditions in conjunction with all other work at the site. The Contractor shall cooperate with the Architect, the Lighting Designer, General Contractor, all other Subcontractors and equipment suppliers working at the site. The Contractor shall coordinate the work and proceed in a manner so as not to delay the progress of the project.

B. The Contractor shall coordinate his work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with other Trades or the Owner by the Contractor shall be assumed by him without any additional cost to the Owner.

C. The Contractor shall furnish information on all equipment that is furnished under this Section but installed under another Section to the installing Subcontractor as specified herein.

D. The Contractor shall provide all materials, equipment and workmanship to provide for adequate protection of all electrical equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Contractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.

E. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Contractor shall be responsible for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.

F. The Contractor shall be responsible for unloading all electrical equipment and materials delivered to the site. This shall also include all large and heavy items or equipment which require hoisting. Consult with the General Contractor for hoisting/crane requirements. During construction of the building, the Contractor shall provide additional protection against moisture, dust accumulation and physical damage of the main service and distribution equipment. This shall include furnishing and installing temporary heaters within these units, as approved, to evaporate excessive moisture and ventilate it from the room, as may be required.

G. It shall be the responsibility of the Contractor to coordinate the delivery of the electrical equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur. Such equipment stored for an excessively long period of time (as determined in the opinion of the Architect and the Lighting Designer) on the project site prior to installation may be subject to rejection by the Architect and/or the Lighting Designer.

H. The Contractor shall erect and maintain, at all times, necessary safeguards for the protection of life and property of the Owner, Workmen, Staff and the Public.

I. Prior to installation, the Contractor has the responsibility to coordinate the exact mounting arrangement and location of electrical equipment to allow proper space requirements as indicated in the NEC. Particular attention shall be given in the field to group installations. If it is questionable that sufficient space, conflict with the work of other Subcontractors, architectural or structural obstructions will result in an arrangement which will prevent proper access, operation or maintenance of the indicated equipment, the Contractor shall immediately notify the Contractor and not proceed with this part of the Contract work until definite instructions have been given to him by the Architect and the Lighting Designer.

3.2 INSTALLATION

A. General

1. Unless specifically noted or indicated otherwise, all equipment and material specified in Part 2 of this specification or indicated on the drawings shall be installed under this Contract whether or not specifically itemized herein. This Section covers particular installation methods and requirements peculiar to certain items and classes or material and equipment.

2. The Contractor shall obtain detailed information from manufacturers of equipment provided under Part 2 of this specification as to proper methods of installation.

3. The Contractor shall obtain final rough-in dimensions and other information as needed for complete installation of items furnished under other Sections or furnished by the Owner.

4. The Contractor shall keep fully informed of size, shape and position of openings required for material and equipment provided under this and other Sections. Ensure that openings required for work of this Section are coordinated with work of other Sections. Provide cutting and patching as necessary.

5. All miscellaneous hardware and support accessories, including support rods, nuts, bolts, screws and other such items, shall be of a galvanized or cadmium plated finish or of another approved rust-inhibiting coating.

6. Throughout this Section where reference is made to steel channel supports, it shall be understood to mean that the minimum size shall be 1 5/8" mild strip steel with minimum wall thickness of 0.105", similar to Unistrut P1000 or equal products manufactured by Kindorf or Husky Products Co. Where reference to channel supports is made under "Lighting Fixtures" paragraph of this Section, the maximum length of span shall be 10'-0". If longer spans are required, the size and wall thickness of the steel channel support shall be as specifically approved and certified by a licensed Structural Engineer.

B. Lighting Fixtures

1. Furnish, assemble, hang and connect all lighting fixtures. Lighting fixtures shall be as indicated on the drawings.

2. Install each fixture properly and safely. Provide hangers, rods, mounting brackets, supports, frames, yokes, support bars and any other equipment required for a complete installation. Refer to Section 260520 for Hangers and Supports.

3. Lay-in recessed fixtures in grid type ceilings shall be supported from the underside of roof or floor slab, and utilize hangers, as indicated in Section 260520, with attachments to building construction independent of other systems. All fixtures shall have a minimum of (2) hangers supports.

4. All lighting fixtures shall be supported from the slab above and shall not be suspended from ducts, piping, equipment, ceiling support system, etc.

5. Where continuous rows of lighting fixtures are installed (pendant mounted), the Electrical Contractor shall furnish and install appropriate mounting channels to properly align fixtures. Use Kindorf or Unistrut channels.

6. Before ordering fixtures, the Electrical Contractor shall verify with the General Contractor the type of ceilings which shall be used in the various spaces.

7. Coordinate fixture locations and mounting heights with the Architectural plans, reflected ceiling plans and other reference data prior to installation. Coordinate fixture types with the electrical lighting drawings.

8. Do not scale electrical drawings for exact location of the lighting fixtures. Consult the architectural reflected ceiling plans for the proper locations of lighting fixtures and dimensions.

9. Prior to fabrication and submittal of shop drawings, check for adequate headroom and non-interference with other equipment such as ducts, pipes or openings.

10. Pendant or surface mounted fixtures shall be provided with required mounting devices and accessories, including hickeys, stud extensions, ball aligners, canopies and stems. Locations of fixtures in mechanical areas shall be coordinated with the Mechanical Contractor. Mounting stems of pendant fixtures shall be of the correct length to uniformly maintain the fixture heights shown on the drawings. Variation in mounting individual fixtures shall not exceed 1/4 inch. Height shall not vary more than 1/2 inch from the floor mounting height shown on the drawings. Fixtures hung in continuous runs shall be installed absolutely level and in line with each other. Hanging devices shall comply with Code requirements. Use single stem hangers (double stem hangers shall not be acceptable). Threaded rods shall be used to support lighting fixtures in those spaces where no other means of support is attainable, and only if fixtures are installed absolutely level with no looseness for movement, and only if approved by Code.

11. Rigidly align continuous rows of lighting fixtures for true in-line appearance, subject to the Architect's and the Lighting Designer’s approval.

12. Install pendant lighting fixtures plumb and at a height from the floor as specified or indicated on the drawings. In cases where conditions make this impractical, refer to the Architect and the Lighting Designer and install as directed. Use ball aligners and canopies on pendant fixtures unless noted otherwise.

13. Do not install fixtures and/or parts such as finishing plates and trims for recessed fixtures until all plastering and painting that may mar fittings finish has been completed.

14. Housings shall be rigidly installed and adjusted to a neat flush fit with the ceiling or other finished mounting surface.

15. The housings of recessed lighting fixtures shall be adequately protected during installation.

16. Install reflector cones, baffles, aperture plates, light controlling element for air handling fixtures, and decorative elements after completion of ceiling tiles, painting and general cleanup.

17. All adjustable and aimable fixtures shall have final adjustment and aiming performed in the presence of and per the direction of the Architect and the Lighting Designer.

18. Replace blemished, damaged or unsatisfactory fixtures as directed by the Architect and/or the Lighting Designer.

19. Exterior poles, bases and any other fixture or fixture components with scratched or damaged finish shall be repainted to match specified color. Pole mounted fixtures shall be provided with inline fuses located in base.

20. Any lamps, drivers, ballasts, reflectors, lenses, diffusers, side panels or other parts damaged prior to the final inspection shall be replaced at no expense to the Owner.

21. At time of final inspection, all fixtures and equipment shall be fully lamped, and shall be complete with required lenses or diffusers, reflectors, side panels, louvers or other necessary components.

22. Each lighting fixture shall be packaged with complete instructions and illustrations showing how to install. Install lighting fixtures in strict conformance with manufacturer's recommendation and instructions.

23. Provide fixtures constructed, wired and installed in compliance with the current edition of applicable City, State and National Codes. Provide fixtures conforming to UL Standards, and to provisions of applicable Codes which exceed those Standards. In addition, provide fixtures which conform to additional Regulations necessary to obtain approval for use of specified fixtures in locations shown. Use only electrical components that are UL listed.

24. Particular attention is called to Article 410 of the NEC. Provide only fixtures that meet these requirements, as interpreted by local agencies. As manufacturers' catalogue numbers may not include thermal protection devices, it is Contractor's responsibility to coordinate the fixture provided with the ceiling construction in accordance with Local Code enforcement practice.

25. Mounting of all lighting fixtures shall conform to seismic requirements.

3.3 MATERIALS AND WORKMANSHIP

A. All materials and equipment shall be new and unused and shall meet requirements of the latest Standards of NEMA, UL, IPCEA, ANSI and IEEE. Equipment shall have components required or recommended by OSHA, applicable NFPA documents and shall be UL listed and labeled.

B. Not used.

C. Finish of materials, components and equipment shall not be less than Industry good practice. When a material or equipment is visible or subject to corrosive or atmospheric conditions, the finish shall be as approved by the Architect and the Lighting Designer.

D. Provide proper access to material or equipment that requires inspection, replacement, repair or service. If proper access cannot be provided, confer with the Architect and the Lighting Designer as to the best method of approach to minimize effects of reduced access.

E. All work shall be installed in a neat and workmanlike manner and shall be done in accordance with all Local and State Codes.

F. The Owner will not be responsible for material, equipment or the installation of the same before testing and acceptance.

3.4 CLEANING AND PROTECTION

A. Clean off excess debris, paint spills, construction materials from adjacent work as construction progresses by methods and with cleaning materials that are approved by each of the manufacturers and that do not damage lighting fixtures or accessories.

B. Provide protection to the completed work and equipment and maintain clean conditions during and after installation to insure that lighting fixtures are not damaged at time of Substantial Completion. If damage or deterioration occurs despite such protection, the Contractor shall remove damaged lighting fixtures immediately and install new lighting fixtures, at no cost to the Owner, per the specified requirements.

3.5 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

A. The Contractor shall prepare and issue, to the Owner's Maintenance Department representative, three (3) copies of all the installed lighting fixture manufacturers labeled per the construction documents, including manufacturer representative contact information, lamp specifications, equipment cuts, wiring diagrams, dimming and control systems information covering all lighting systems installed under this section. The material shall be bound in notebook form and indexed.

B. In addition, prior to substantial completion, the Contractor shall give detailed instructions and explanation of the maintenance manual and in the operation and maintenance of all work installed under this section to the Owner's Maintenance Department representative.

END OF SECTION 265010

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Cosentini
A TETRA TECH COMPANY

Consulting Engineers - Lighting Design
498 Seventh Avenue
New York, NY 10018

T: 212.615.3600
F: 212.615.3700

www.cosentini.com

M. A. Mass, PE
D. C. Mass, PE
M. W. Maybaum, PE
E. Barbieri, PE
R. Leber, PE
S. R. Ceasar, PE
D. DeRobertis, PE

REGENERON TTCX
B17 CHILD DAY-CARE CENTER

777 OLD SAW MILL RIVER ROAD
MOUNT PLEASANT, NY 10591

APPENDIX A - LIGHTING FIXTURE CUTS
ISSUED FOR PERMIT

PROJECT #210104
05.20.2022

Project		Catalog #		Type	
Prepared by		Notes		Date	

Metalux

Industrial LED Linear Bay

LED Linear Bay Lighting System

Typical Applications
Big Box Retail • Shopping Malls • School Gymnasium • Light Industrial • Warehouse • Manufacturing

Interactive Menu

Product Certification

Product Features

damp location

LINEAR DISCONNECT
Safe and convenient means of disconnecting power

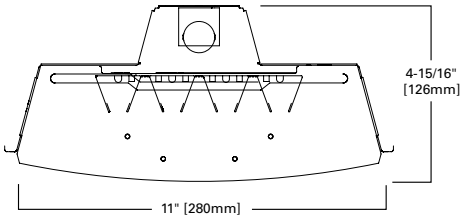
MWS MODULAR WIRING SYSTEM CLICK HERE

Top Product Features

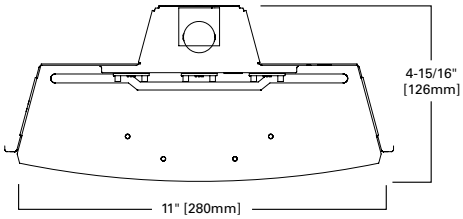
- 4ft and 8ft low profile, narrow 11" wide housing
- Available in surface, suspended and continuous row mount
- Multiple lumen packages available
- High-performance efficacy up to 160 lm/W
- Multiple Lumen Packages for Low Bay and High Bay Applications
- Options to meet Buy American and other domestic preference requirements

Dimensional and Mounting Details

NARROW DISTRIBUTION



WIDE DISTRIBUTION



additional product diagrams

Order Information

SAMPLE ORDER NUMBER: **4ILED-LD5-9-W-FL-UNV-L840-CD1-U**

Domestic Preferences	Length	Series	Mounting Arrangement	Lamp Type	Lumen Output	Distribution	Shielding Options
[Blank]=Standard **BAA**=Buy American Act **TAA**=Trade Agreements Act	**4**=4' Length **8**=8' Length	**ILED**=LED High Bay	**[Blank]**=Stand Alone **R**=Continuous Row Mount	**LD5**=LED 5.0	**4 ft.** **5**=5,000 Lumens **7**=7,000 Lumens **9**=9,000 Lumens **11**=11,000 Lumens **14**=14,000 Lumens **16**=16,000 Lumens (3) **8 ft.** **10**=10,000 Lumens **14**=14,000 Lumens **18**=18,000 Lumens **22**=22,000 Lumens **28**=28,000 Lumens **32**=32,000 Lumens (3)	**N**=Narrow (4) **W**=Wide	**[Blank]**=Open **TBW**=Thin White Baffle (6) **FL**=Frosted Acrylic Lens & Frame (5), (6) **FL/UPL**=Frosted Lens w/ Uplight (5), (6) **CL**=Clear Acrylic Lens & Door Frame (5), (6) **WG**=Heavy Duty Wireguard
Notes (1) Only product configurations with these designated prefixes are built to be compliant with the Buy American Act of 1933 (BAA) or Trade Agreements Act of 1979 (TAA), respectively. Please refer to DOMESTIC PREFERENCES website for more information. Components shipped separately may be separately analyzed under domestic preference requirements.		**Notes** (2) DesignLights Consortium® Qualified and classified for both DLC Standard and DLC Premium, refer to www.designlights.org for details.			**Notes** (3) Max. ambient 40C for 16K and 32K lumen packages.	**Notes** (4) Narrow distribution not available with FL, FL/UPL, and CL shielding options.	**Notes** (5) Narrow distribution not available with FL, FL/UPL, and CL shielding options. (6) Wireguard available in conjunction with shielding option (catalog example TBW/WG).

Voltage	CCT	Emergency Options	Driver Type
UNV=Universal 120-277 Voltage **UNC**=Universal 347/480 Voltage **120V**=120 Volt **277V**=277 Volt **347V**=347 Volt (7) **480V**=480 Volt (7)	**L830**=3000K **L835**=3500K **L840**=4000K **L850**=5000K	**EL7W**=Emergency Installed, 7 Watts (8), (9) **EL14W**=Emergency Installed, 14 Watts (8), (9) **GTR2**=Bodine Generator Transfer Relay (10) **ETRD**=Iota Emergency Transfer Relay with dimming control (10)	**CD**=0-10V Dimming (standard) **1**=1 Driver **2**=2 Drivers (14,000, 16,000, 18,000, 22,000 lumen) **3**=3 Drivers (32,000 lumen) **4**=4 Driver (28,000 lumen) **SD**=Step-dim Driver **1**=1 Driver **2**=2 Drivers (10,000, 11,000, 14,000 lumen) **3**=3 Drivers (16,000, 18,000, 22,000 lumen) **4**=4 Drivers (28,000, 32,000 lumen) **5LTD**=Fifth Light DALI **1**=1 Driver **2**=2 Drivers (14,000, 16,000, 18,000, 22,000 lumen) **3**=3 Drivers (28,000, 32,000 lumen)
Notes (7) EL not available in 347 or 480V configurations.		**Notes** (8) Max. ambient 35C for EL options. (9) EL not available in 347 or 480V configurations. (10) Used to bypass local control during outage. Must be used in conjunction with UL 1008 device (provided by others). GTR2 option includes 2 relays on fixtures with dimming drivers. ETRD option only requires one relay when used on a dimming fixture. Must specify voltage as 120V or 277V when ordering these devices.	

Wiring Options	Packaging	Accessories (order separately) (13)
PI_NG=Plug In System (1, 2, or 3 Circuit Capability), No Ground (ground provided by fixture body) (11) **PI_WG**=Plug In System (1, 2, or 3 Circuit Capability), With Ground (separate ground wire in harness) (11) **CPI_NG**=Crossover Plug In System (2 or 3 Circuit Capability), No Ground (ground provided by fixture body) (11) **CPI_WG**=Crossover Plug In System (2 or 3 Circuit Capability), With Ground (separate ground wire in harness) (11) **MWS**=Modular Wiring System **MS**=360° or 180° Motion Sensor, 120 through 347, or 480V **MP**=Modular Power Receptacle (Used for all Cord or Cord and Plug options)	**U**=Unit Pack **PAL**=Palletized Out of Carton **PALC**=Palletized In Carton	**ILED-SPM**=Single Monopoint Hanger w/Hub **FH-1**=Fixture Hook **FL-1**=Fixture Loop **SHK**=Fixture Hook **AYC-CHAIN/SET/U**=(2) Hooks, 36" Chain Sets w/S-Hooks **TOGGLE-**=Single Toggle, #2 Cable (Specify 10' or 30') **LOOP-**=Loop Hanger, #2 Cable (Specify 10' or 30') **MC6**=6' Modular Power Cord **MPC6**=6' Modular Power Cord & Plug (Specify Voltage) **MMS**=360° or 180° Aisle Motion Sensor with Modular Power Receptacle (120-277V) **MDS6**=6' Modular Power Cord with MWS 27DS18/2G06MP Connector **Door Frames** (for Field Installation) (12) **ILED-4-FRM/FL-PK**=4 ft. Frosted Acrylic Lens & Frame **ILED-4-FRM/CL-PK**=4 ft. Clear Acrylic Lens & Frame **ILED-4-WG-PK**=4 ft. Wireguard **ILED-4-TBW-PK**=4 ft. Thin White Baffle
Notes (11) PI option does not include low voltage wiring for 0-10V dimming.		**Notes** (12) 8 ft. fixtures require two door frames per fixture. (13) Accessories sold separately will be separately analyzed under domestic preference requirements. Consult factory for further information.

PI Option Ordering Information

Catalog Number Suffix	Number of Circuits	Circuit Wired To Ballast
PI 1 BLK	1	Black
PI 2 BLU	2	Blue
PI 2 BLK	2	Black
PI 3 RED	3	Red
PI 3 BLU	3	Blue
PI 3 BLK	3	Black

Catalog Numbering System

The PI System is available in sections up to 8' in length for continuous row wiring by simply plugging the sections together. Each PI section is factory wired to the ballast leads. Color coding of wires is as follows:

PI-1 = One Circuit - 2 Wires: one black, one white
PI-2 = Two Circuits - 3 Wires: one black, one blue, one white
PI-3 = Three Circuits - 4 wires: one black, one blue, one red, one white

When ordering the PI2/PI3 System it is necessary to specify the number of fixtures required for each circuit. Each circuit in fixture must be ordered as a separate line item, with a different hot wire color specified. All wiring to external feeds, using cord or cord & plug, are responsibility of installing licensed contractor. Cord and cord & plug sets must be ordered separately if PI option is chosen.

PI1 - Single Circuit Plug-In

SAMPLE ORDER NUMBER: **PI1BLK-WG**

Catalog Number Suffix – Ground Wires

Catalog Number Suffix	Ground Wires
PI1=Single Circuit	**NG**=No Ground (ground provided by fixture body)
BLK=Black Hot	**WG**=With Ground (separate ground wire in harness)

PI2 - Two Circuit Plug-In

SAMPLE ORDER NUMBER: **PI2BLK-WG**

Catalog Number Suffix – Ground Wires

Catalog Number Suffix	Ground Wires
PI2=Two Circuit	**Leave Blank**=Single Neutral **2NEU**=Two Neutrals
BLK=Black Hot **BLU**=Blue Hot	
Leave Blank=Single Neutral **/WHT**=White Neutral **/GRY**=Gray Neutral	**NG**=No Ground (ground provided by fixture body) **WG**=With Ground (separate ground wire in harness)

PI3 - Three Circuit Plug-In

SAMPLE ORDER NUMBER: **PI3BLK-WG**

Catalog Number Suffix – Ground Wires

Catalog Number Suffix	Ground Wires
PI3=Three Circuit	**Leave Blank**=Single Neutral **2NEU**=Two Neutrals
BLK=Black Hot **BLU**=Blue Hot **RED**=Red Hot	
Leave Blank=Single Neutral **/WHT**=White Neutral **/GRY**=Gray Neutral	**NG**=No Ground (ground provided by fixture body) **WG**=With Ground (separate ground wire in harness)

Specifications & dimensions subject to change without notice. Consult your Cooper Lighting Solutions Representative for availability and ordering information.

Product Specifications

Construction
- Specification grade, full body housing
- End plates and socket tracks are die formed cold rolled steel
- Available in 4' and 8' lengths
- Integral driver channel for added strength
- Numerous KO's for easy installation

Electrical
- LED's available in 3500K, 4000K, and 5000K with a CRI > 80
- Available for 120-277V, 347V and 480V
- 0-10V dimming driver standard
- Optional modular power receptacle meets UL2459 and NEC 410.73
- UL/cUL rated for make and break under load from outside of the luminaire

Finish
- Electrostatically applied, baked white enamel finish
- Multistage cleaning cycle
- Iron phosphate coating with rust inhibitor

Optics
- Optical modules are enclosed inside housing to protect against damage
- Available in narrow or wide distribution
- Narrow beam optical module utilizes 95% specular aluminum finish
- Optional thin white baffle available for longitudinal shielding
- Clear or frosted acrylic lens available
- Heavy duty wireguard available
- Latched retention of shielding optics allows for easy access

Mounting
- Suitable for surface, suspension mounting with optional wire hook and chain set, stem or cable mounting
- Top connector box mounting available
- Narrow 11" housing allows mounting within 12" horizontally from the nearest edge of sprinkler deflector

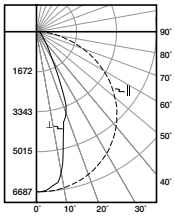
Compliance
- cULus listed for damp locations -20 C – 45 C ambient environments
- RoHS compliant
- LED modules comply with IESNA LM-79/LM-80 testing standards
- DesignLights Consortium Qualified and classified for both DLC Standard and DLC Premium, refer to www.designlights.org for details

Integrated Controls
- MS integrated sensor provides 600 sqft of coverage at maximum height of 40'
- MSO integrated sensor provides 1250 sqft of coverage at maximum height of 40'

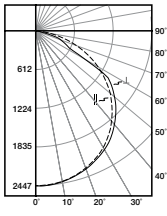
Warranty
- Five year warranty.

Photometric Data

View IES files



4ILED-LD5-7-N-UNV-L840-CD1-U
Electronic Driver
Linear LED 4000K
Spacing criterion: (II) 1.27 x mounting height, (⊥) 0.59 x mounting height
Lumens: 6730
Input Watts: 50.4W
Efficacy: 133.5 lm/W
Test Report: 4ILED-LD5-7-N-UNV-L840-CD1-U.IES



4ILED-LD5-7-W-UNV-L840-CD1-U
Electronic Driver
Linear LED 3500K
Spacing criterion: (II) 1.29 x mounting height, (⊥) 1.32 x mounting height
Lumens: 7060
Input Watts: 50.4W
Efficacy: 140.1 lm/W
Test Report: 4ILED-LD5-7-W-UNV-L840-CD1-U.IES

Energy and Performance Data

Energy and Performance Data by Catalog Number

Catalog Number	Delivered Lumens	Watts	Efficacy (lm/W)
4 ft. Length			
4ILED-LD5-5-W-UNV-L840-CD1-U	5007	31	160
4ILED-LD5-7-W-UNV-L840-CD1-U	6996	46	152
4ILED-LD5-9-W-UNV-L840-CD1-U	9051	60	151
4ILED-LD5-11-W-UNV-L840-CD1-U	10949	79	139
4ILED-LD5-14-W-UNV-L840-CD1-U	13962	98	143
4ILED-LD5-16-W-UNV-L840-CD1-U	16050	113	142
8 ft. Length			
8ILED-LD5-10-W-UNV-L840-CD1-U	10014	63	160
8ILED-LD5-14-W-UNV-L840-CD2-U	13993	92	152
8ILED-LD5-18-W-UNV-L840-CD2-U	18102	120	151
8ILED-LD5-22-W-UNV-L840-CD2-U	21898	157	139
8ILED-LD5-28-W-UNV-L840-CD4-U	27924	195	143
8ILED-LD5-32-W-UNV-L840-CD3-U	32100	226	142

Ambient Ratings

Lumen Package	Ambient Rating	Drivers			Lensed	EM
		CD	SD	5LTD		
4ILED-LD5-5	45ºC	45ºC	45ºC	45ºC	45ºC	35ºC
4ILED-LD5-7	45ºC	45ºC	45ºC	45ºC	45ºC	35ºC
4ILED-LD5-9	45ºC	45ºC	45ºC	45ºC	45ºC	35ºC
4ILED-LD5-11	45ºC	45ºC	45ºC	45ºC	45ºC	35ºC
4ILED-LD5-14	45ºC	45ºC	45ºC	45ºC	45ºC	35ºC
4ILED-LD5-16	40ºC	40ºC	40ºC	40ºC	40ºC	35ºC

Lumen Maintenance

Ambient Temperature	TM-21 Lumen Maintenance (60,000 hours)	Theoretical L70 (Hours)
25ºC	> 86%	171,000

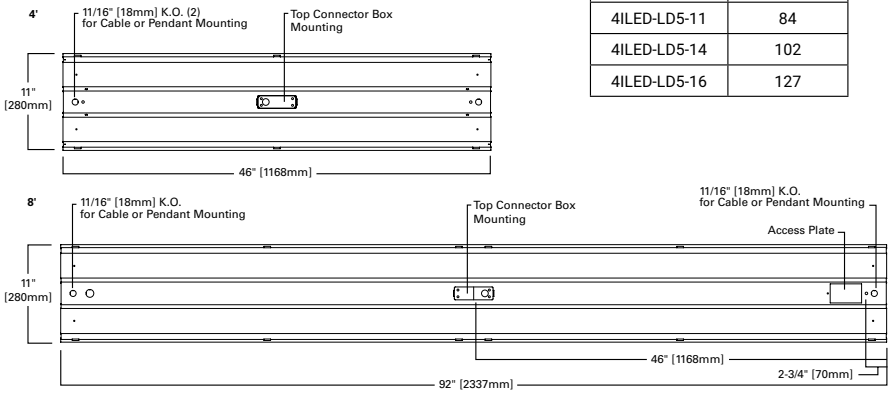
Energy Data

Catalog No.	Input Watts
4ILED-LD5-5	33
4ILED-LD5-7	50
4ILED-LD5-9	66
4ILED-LD5-11	84
4ILED-LD5-14	102
4ILED-LD5-16	127

Shipping Data

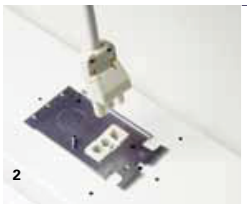
Catalog No.	Wt.
4ILEDL	15 lbs.
8ILED	30 lbs.

Dimensional and Mounting Details



Modular F-Bay Power Supply Option

Cooper Lighting's F-Bay Modular Power Supply option is available for use with all F-Bay products. The modular power supply allows external fixture access for safe and easy servicing. There is no need to remove lamps or reflectors to disconnect fixture power with F-Bay Modular Power Supply. Access to the individual fixture's power supply allows servicing without turning off all the fixtures, disrupting occupants. F-Bay Modular Power Supply is a time saver in installation – ***simply plug & power.***



1. Modular Power Supply Receptacle supplied mounted into fixture Access Plate
2. Modular Power Cord & Plugs in 120, 277, 347, & 480V configurations for easy plug & power into existing supply

No internal fixture access required for installation or disconnecting power

Modular Motion Sensor Option supplied with Mounting Box and Modular Power Supply Receptacle

Code Compliance

- UL/cUL Certified for Make/Break under load (UL2549)
- Meets NEC requirements for ballast disconnect (NEC 410.73G)
- Allows for addition of Occupancy Sensor without hard connections
- Receptacles complete with insulating/dust cap

Cooper Lighting Solutions
1121 Highway 74 South
Peachtree City, GA 30269
P: 770-486-4800
www.cooperlighting.com

LITHONIA LIGHTING®

Catalog Number	
Notes	
Type	

FEATURES & SPECIFICATIONS

INTENDED USE

Provides years of maintenance-free illumination for indoor or outdoor use in residential & commercial applications.

CONSTRUCTION

Cast-aluminum housing with corrosion-resistant paint in an industrial grey finish.

Sealed gasket protects against moisture and dust.

OPTICS

4000K CCT LEDs.

Frosted glass diffuser provides even light distribution.

LUMEN MAINTENANCE

LEDs will deliver 70% of their initial lumens at 50,000 hour average LED life. See Lighting Facts label on page 2 for performance details.

ELECTRICAL

MVOLT driver operates on any line voltage from 120-277V

Operating temperature -40ºC to 40ºC.

4kV surge protection standard.

INSTALLATION

Mounts to ceiling or wall with surface mount junction box (included).

LISTINGS

UL Listed to U.S. and Canadian safety standards for wet locations.

Tested in accordance with IESNA LM-79 and LM-80 standards.

WARRANTY

5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Full warranty terms located at www.AcuityBrands.com/CustomerResources/Terms_and_Conditions.aspx

Note: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications are subject to change without notice.

Outdoor General Purpose

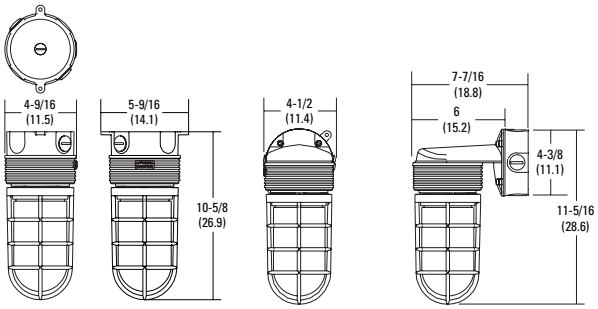
OLVTCM & OLVTWM

LED VAPORTIGHT

LED

Specifications

All dimensions are inches (centimeters)



ORDERING INFORMATION For shortest lead times, configure products using **bolded options**. **Example:** OLVTCM

Series	Color temperature	Voltage	Finish
OLVTCM Ceiling MT **OLVTWM** Wall MT	**(blank)** 4000K	**(blank)** MVOLT (120V-277V)	**(blank)** Grey

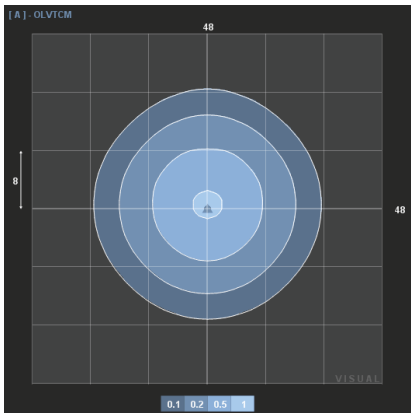
Series	System Wattange	Lumens
OLVTCM	15W	600
OLVTWM	15W	600

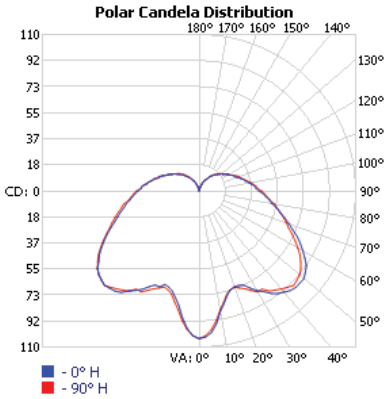
OLVTCM & OLVTWM LED Vaportight

PHOTOMETRICS

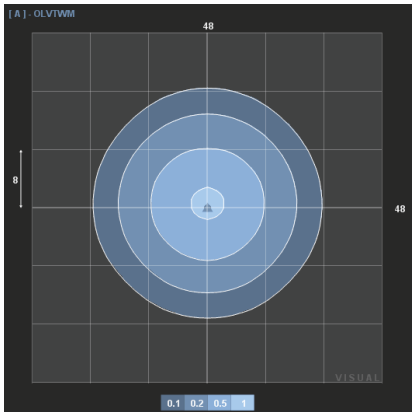
To see complete photometric reports or download .ies files for this product,visit Lithonia Lighting's Outdoor LED homepage
Tested in accordance with IESNA LM-79 and LM-80 standards.

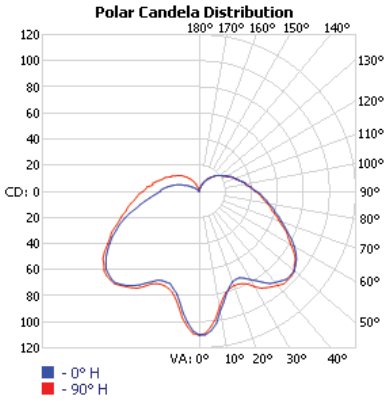
OLVTCM





OLVTWM





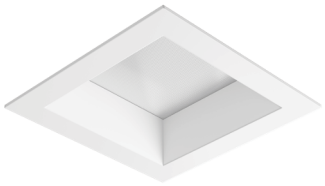
LITHONIA LIGHTING®
An AcuityBrands Company

DECORATIVE INDOOR & OUTDOOR: One Lithonia Way Conyers, GA 30012 Phone: 1-800-705-SERV (7378) www.lithonia.com

TECH LIGHTING

ELEMENT™ 4" PRO SERIES LED

FIXED DOWNLIGHT



SHOWN IN FLANGED SQUARE

The Element 4" Pro Series Fixed downlight introduces a budget-friendly, specification-grade downlight with wide-angle distribution for commercial applications. Engineered with a precision diffuser and Solite Soft Focus lens that eliminates hot spots, direct visibility into the housing, and delivers a clean aperture and ceiling aesthetic. The Element 4" Pro Series is offered in a variety of options, including multiple outputs, beam spreads and the choice of Static White, Warm Dim or Tunable White to meet any commercial requirements.

- Budget-friendly solution for commercial spaces
- High-Output and wide-angle beam spreads engineered for large spaces
- 1-step standard color binning
- High efficacy: >100 lumens per watt (reference specification chart for detail)
- Lutron/eldoLED options

LUMEN MULTIPLIER (CRI/CCT)

CCT	80 CRI MULTIPLIER	90 CRI MULTIPLIER
2700K	0.95	0.80
3000K	1.00	0.85
3500K	1.05	0.90

Lumen output will vary by CCT and CRI.
See photometric charts for output information.

SPECIFICATIONS

		STATIC WHITE		WARM DIM		TUNABLE WHITE	
HOUSING (RATING)	Wattage	Lumens	Efficacy	Lumens	Efficacy	Lumens	Efficacy
E4PH (IC/NIC/CP) E4PEMH (NIC/CP)	7W	750	104	612	77	516	65
	12W	1200	103	919	77	774	65
	15W	1500	100	1302	77	1097	65
E4PH (IC/NIC/CP) E4NGEMH (NIC/CP)	19W	1900	99	1839	77	1548	65
E4NGH (IC/NIC/CP) E4NGEMH (NIC/CP)	27W	2550	94	2375	77	2000	65
E4NGH (NIC/CP) E4NGEMH (NIC/CP)	36W	3200	90	NA		NA	
CRI		80+, 90+		90+		90+	
CCT		2700K, 3000K, 3500K, or 4000K		3000K - 1800K		5000K - 2700K	
COLOR CONSISTENCY		1-step		3-step		2-step	
VOLTAGE		120V or 277V					
DIMMING[1]		Standard reverse-phase, forward-phase, TRIAC, and 0-10V dimming (down to 1% or 5%+ depending on wattage) Lutron Hi-lume EcoSystem (down to 0.1%) | Lutron Hi-lume 2-wire (down to 1%) EldoLED 0-10V or Dali (down to 0.1%)				EldoLED 0-10V or Dali (down to 0.1%)	
POWER SUPPLY		Constant current driver with +.9 power factor and +80% efficiency					
BEAM SPREAD		65°, 75°, 85°, or 95° Note: Optics are not field changeable					
ADJUSTABILITY		N/A					
CEILING APPEARANCE		Flanged, Flangeless or Flangeless in Wood Ceiling					
CEILING THICKNESS		Flanged: Up to 2-1/2" | Flangeless: No ceiling thickness limitations | Flangeless in Wood Ceiling: No ceiling thickness limitations					
CEILING APERTURE		4-1/2" ceiling cutout					
HOUSING		IC Airtight, Non-IC Airtight, Chicago Plenum. IC suitable up to R60 spray foam insulation.					
CONSTRUCTION		Housing: Heavy-Gauge, Cold-Rolled Steel | Trims: Die-Cast Aluminum					
FINISH		Housing: Black Powder Coat | Trim: Select finish options for Bevel and Flange separately: White, Black, Haze Silver					
GENERAL LISTINGS		ETL Listed. Wet Listed.					
CALIFORNIA TITLE 24		Registered CEC Appliance Database. Can be used to comply with CEC 2019 Title 24 Part 6 (JA8-2016, JA8-2019) (for 90 CRI versions).					
L70		50,000 hours min					
WARRANTY[2]		5 years					

Data in chart reflects 3000K/80CRI values unless noted. Lumen values are delivered lumens, not source lumens.
Custom Output/Custom RAL/Custom CCT available, Contact Quotes Department
Ordering grids available on page 2.
[1]See ELEMENT-Lighting.com for dimmer compatibility.
[2]Visit ELEMENT-Lighting.com for specific warranty limitations and details.

UPDATED 3/4/22

TECH LIGHTING®

ELEMENT™ 4" PRO SERIES LED

FIXED DOWNLIGHT

ORDERING GRIDS

HOUSING

PRODUCT	CEILING APPEARANCE	OUTPUT	FUNCTION	HOUSING RATING	DRIVER	VOLTAGE
E4PR ELEMENT 4" PRO SERIES ROUND **E4PS** ELEMENT 4" PRO SERIES SQUARE	**L** FLANGELESS **F** FLANGED **WC** WOOD CEILING[1]	**-L07** 7W (750 LMS)[2] **-L12** 12W (1200 LMS) **-L15** 15W (1500 LMS) **-L19** 19W (1900 LMS) **-L27** 27W (2550 LMS) **-L36** 36W (3200 LMS)[3]	**D** DOWNLIGHT GENERAL ILLUMINATION	**I** IC AIRTIGHT **N** NON-IC AIRTIGHT **C** CHICAGO PLENUM **E** EMERGENCY BATTERY BACK-UP (NON-IC AIRTIGHT/ CHICAGO PLENUM)[4]	**INTEGRATED DRIVERS 120V/277V** UNIVERSAL PHASE/0-10V 1% (LEAVE BLANK)[5] **-ELD0** ELDOLED 0.1% 0-10V LINEAR **-ELD0A** ELDOLED 0.1% 0-10V LOGARITHMIC **-ELDD** ELDOLED 0.1% DALI **-ELT0** ELDOLED TUNABLE WHITE 0.1% 0-10V LINEAR 2-WIRE[6] **-ELTD** ELDOLED TUNABLE WHITE 0.1% DALI[6] **-HLECO** LUTRON HI-LUME 0.1% ECOSYSTEM[7] **INTEGRATED DRIVERS 120V** **-HL2W** LUTRON HI-LUME 1% 2-WIRE	120 VOLT (LEAVE BLANK) **-2** 277 VOLT
		-	D			

See Driver and Wattage Housing Compatibility Chart below for information on IC and Non-IC options.
Trims are required and must be ordered separately.
Hanger bars not included with smaller E4PH and E4PEMH Housings. Order separately if required.
Output lists nominal wattage and lumens at 3000K/80CRI; actual wattage and lumens may vary slightly.
[1]WC - Wood Ceiling accommodates Flangeless trims only. For flanged trims in a wood ceiling use standard flanged housing.
[2]L07 - Dimming performance with standard UNIVERSAL PHASE/0-10V driver varies dramatically from <1% to >10% depending on the dimmer; please refer to Dimmer Compatibility chart.
[3]L36 - Output only available Non-IC/CP. Not available with WD31 Warm Dim or TW52 Tunable White. Not available with HL2W and HLECO drivers.
[4]E - Emergency Battery Back-up available in smaller E4PEMH Housing (above ceiling access required) only for L07, L12 and L15 output. Emergency battery back-up available in larger E4NGEMH Housing only for L19, L27 and L36 output. For use with DEM trims only.
[5]Universal dimming is reverse-phase, forward-phase, and TRIAC. The standard UNIVERSAL PHASE/0-10V driver dims to 1% with L12 and L15, and to 5% with L07, L19, L27 and L36. Dimming performance varies by dimmer; please refer to Dimmer Compatibility chart.
[6]ELT0/ELTD - Tunable White TW52 available with ELT0 (0-10V, linear) or ELTD (DALI) only. For 0-10V logarithmic dimming consult Quotes Department.
[7]HLECO - Lutron has put their entire 0.1% ECO drivers on indefinite hold which impacts all -HLECO item numbers. Please consult factory for alternatives. This does not impact -HL2W.

TRIM/LIGHT MODULE

PRODUCT	CEILING APPEARANCE	STYLE	FUNCTION	CRI/CCT	BEAM SPREAD	BEVEL FINISH	FLANGE FINISH
E4PR ELEMENT 4" PRO SERIES ROUND **E4PS** ELEMENT 4" PRO SERIES SQUARE	**L** FLANGELESS **F** FLANGED **F15** FLANGED 1.1"-1.5" CEILING THICKNESS **F20** FLANGED 1.6"-2.0" CEILING THICKNESS **F25** FLANGED 2.1"-2.5" CEILING THICKNESS	**R** REGRESS (1.0")	**D** DOWNLIGHT GENERAL ILLUMINATION **DEM** DOWNLIGHT GENERAL ILLUM. EM[1]	**-830** 80 CRI, 3000K, 1-STEP **-835** 80 CRI, 3500K, 1-STEP **-840** 80 CRI, 4000K, 1-STEP **-927** 90 CRI, 2700K, 1-STEP **-930** 90 CRI, 3000K, 1-STEP **-935** 90 CRI, 3500K, 1-STEP **-940** 90 CRI, 4000K, 1-STEP **-WD31** 90 CRI, 3000K-1800K, WARM DIM, 3-STEP[2] **-TW52** 90 CRI, 5000K-2700K, TUNABLE WHITE, 2-STEP[3]	**6** 65° DIFFUSER WITH SOLITE **7** 75° DIFFUSER WITH SOLITE **8** 85° DIFFUSER WITH SOLITE **9** 95°+ DIFFUSER WITH SOLITE	**-W** WHITE **-B** BLACK **-HS** HAZE SILVER	FLANGELESS ONLY (LEAVE BLANK) **W** WHITE **B** BLACK
		R		-			

[1]DEM - Downlight General Illumination EM Trim has test switch integrated into bevel portion of trim. For use with E4PEMH and E4NGEMH Housings only.
[2]WD31 - Warm Dim not available with HL2W for L07 and L36 output, and not available with HLECO for L07, L19, L27, and L36 output.
[3]TW52 - Tunable White for use with ELT0 (0-10V, linear) or ELTD (DALI) Housings only. For 0-10V logarithmic dimming or TW41 4000K-1800K consult Quotes Department. Not available for L36 output.

HANGER BARS

PRODUCT	STYLE
HNGBAR HANGER BAR SET	**-S** STANDARD **-P** PREMIUM[1]
HNGBAR	-

Order one set per fixture if required.
Hanger bars can be extended from 14" to 24" unless otherwise noted.
[1]P - Premium Hanger Bar Set has a standard extended length from 10"-24".
To extend to 36", order two sets per fixture and join together.
To extend to 48", order three sets per fixture and join together.

DRIVER AND WATTAGE HOUSING COMPATIBILITY CHART

ITEM NUMBER	DESCRIPTION	WATTAGE						
		E4PH HOUSING				E4NGH HOUSING		
		L07	L12	L15	L19	L19	L27	L36[2]
	STANDARD REVERSE-PHASE, FORWARD-PHASE, AND TRIAC 1% OR 5%+ DEPENDING ON WATTAGE[1]	IC	IC	IC	IC	-	IC	NON-IC
-010	0-10V DIMMING 1% OR 5%+ DEPENDING ON WATTAGE	IC	IC	IC	IC	-	IC	NON-IC
-ELD0	ELDOLED 0.1% 0-10V LINEAR	IC	IC	IC	IC	-	IC	NON-IC
-ELD0A	ELDOLED 0.1% 0-10V LOGARITHMIC	IC	IC	IC	IC	-	IC	NON-IC
-ELDD	ELDOLED 0.1% DALI	IC	IC	IC	IC	-	IC	NON-IC
-ELT0	ELDOLED TUNABLE WHITE 0.1% 0-10V LINEAR	IC	IC	IC	IC	-	IC	NON-IC
-ELTD	ELDOLED TUNABLE WHITE 0.1% DALI	IC	IC	IC	IC	-	IC	NON-IC
-HL2W	LUTRON HI-LUME 1% 2-WIRE	IC	IC	IC[1]	NON-IC	IC	NON-IC	-
-HLECO	LUTRON HI-LUME 0.1% ECOSYSTEM	IC	IC	IC	IC	-	IC	-

[1]No Branch Wiring.
[2]L36 Output only available Non-IC/CP in larger E4NGH Housing. Not available with WD31 Warm Dim or TW52 Tunable White.
Emergency Battery Back-up available in smaller E4PEMH Housing (above ceiling access required) only for L07, L12 and L15 output.
Emergency Battery Back-up available in larger E4NGEMH Housing only for L19, L27 and L36 output.

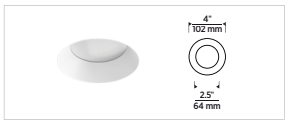
TECH LIGHTING

ELEMENT™ 4" PRO SERIES LED

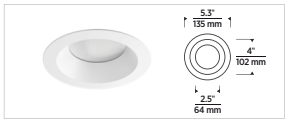
FIXED DOWNLIGHT

TRIMS

ROUND

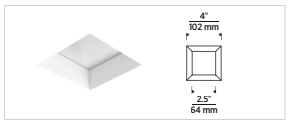


FLANGELESS

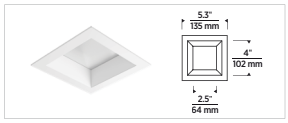


FLANGED

SQUARE



FLANGELESS



FLANGED

FINISH OPTIONS

NO FLANGE

HAZE SILVER BEVEL

BLACK BEVEL

WHITE BEVEL

WHITE FLANGE

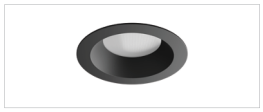
WHITE FLANGE, HAZE SILVER BEVEL

WHITE FLANGE, BLACK BEVEL

WHITE FLANGE, WHITE BEVEL

BLACK FLANGE

BLACK FLANGE, HAZE SILVER BEVEL



BLACK FLANGE, BLACK BEVEL

BLACK FLANGE, WHITE BEVEL

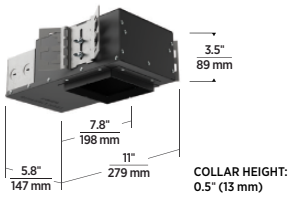
TECH LIGHTING

ELEMENT™ 4" PRO SERIES LED

FIXED DOWNLIGHT

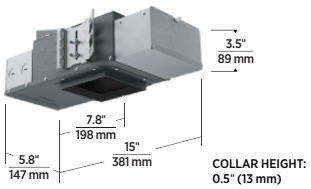
HOUSINGS

E4PH



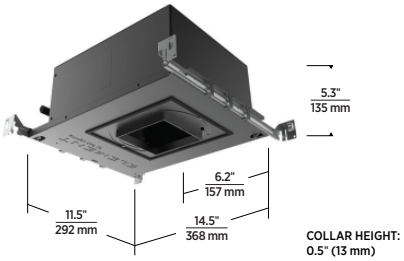
IC AIRTIGHT / NON-IC AIRTIGHT /
CHICAGO PLENUM (UP TO 19W)

E4PEMH



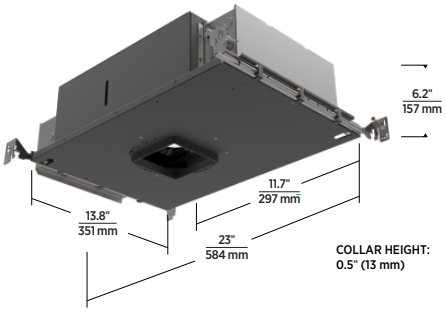
EMERGENCY BATTERY AIRTIGHT (NON-IC) /
CHICAGO PLENUM (UP TO 15W)
(ABOVE CEILING ACCESS REQUIRED)

E4NGH



IC AIRTIGHT / NON-IC AIRTIGHT /
CHICAGO PLENUM (27W AND ABOVE)
BELOW CEILING ACCESS PROVIDED

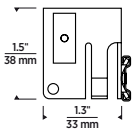
E4NGEMH



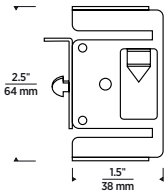
EMERGENCY BATTERY (NON-IC) AIRTIGHT /
CHICAGO PLENUM (19W AND ABOVE)
BELOW CEILING ACCESS PROVIDED

HANGER BARS

STANDARD



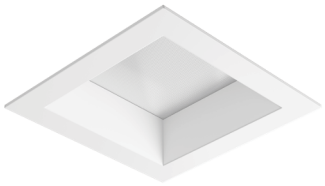
PREMIUM



TECH LIGHTING

ELEMENT™ 4" PRO SERIES LED

ADJUSTABLE DOWNLIGHT



SHOWN IN FLANGED BEVEL SQUARE

The Element 4" Pro Series Adjustable Downlight features full adjustability with lockable, tool-free hot aiming, including patented high/low lamp positioning. Engineered with a precision diffuser and Solite Soft Focus lens that eliminates hot spots, direct visibility into the housing, and delivers a clean aperture and ceiling aesthetic. Complementing the Element 4" Pro Series Fixed downlight, the Adjustable is offered in a variety of options, including output, beam spreads and the choice of Static White, Warm Dim or Tunable White to complete any commercial installation.

- 2-step standard
- Solite Soft Focus Lens plus diffuser standard
- Tool-free aiming/locking: 0-40° tilt, 361° rotation
- Patented high/low lamp positioning
- Lutron/eldoLED options

LUMEN MULTIPLIER (CRI/CCT)

CCT	80 CRI MULTIPLIER	90 CRI MULTIPLIER
2700K	0.95	0.80
3000K	1.00	0.85
3500K	1.05	0.90

Lumen output will vary by CCT and CRI.
See photometric charts for output information.

SPECIFICATIONS

	STATIC WHITE		WARM DIM		TUNABLE WHITE	
WATTAGE	Lumens	Efficacy	Lumens	Efficacy	Lumens	Efficacy
8W	675	84	551	70	464	58
12W	990	83	826	70	697	58
17W	1350	79	1170	69	987	58
24W	1800	75	1569	65	1393	58
29W	2430	84	2137	69	1800	62
36W	2880	80	NA		NA	
CRI	80+, 90+		90+		90+	
CCT	2700K, 3000K, 3500K, or 4000K		3000K - 1800K		4000K - 1800K or 5000K - 2700K	
COLOR CONSISTENCY	2-step		3-step		2-step	
VOLTAGE	120V or 277V					
DIMMING[1]	Standard reverse-phase, forward-phase, TRIAC, and 0-10V dimming (down to 1% or 5%+ depending on wattage) Lutron Hi-lume EcoSystem (down to 0.1%) | Lutron Hi-lume 2-wire (down to 1%) EldoLED 0-10V or Dali (down to 0.1%)				EldoLED 0-10V or Dali (down to 0.1%)	
POWER SUPPLY	Constant current driver with +.9 power factor and +80% efficiency					
BEAM SPREAD	18°, 25°, 40°, or 60°					
ADJUSTABILITY	0-40° tilt, 361° rotation, high/low lamp positioning, 45° collar rotation					
CEILING APPEARANCE	Flanged, Flangeless, Flangeless in Wood Ceiling					
CEILING THICKNESS	Flanged: Up to 2-1/2" Flangeless: No ceiling thickness limitations | Flangeless in Wood Ceiling: No ceiling thickness limitations Note: Thicker ceilings impact light cut off					
CEILING APERTURE	4-1/2" ceiling cutout					
HOUSING	IC Airtight, Non-IC Airtight, Chicago Plenum, IC suitable up to R60 spray foam insulation					
CONSTRUCTION	Housing: Heavy-Gauge, Cold-Rolled Steel | Trims: Die-Cast Aluminum					
FINISH	Housing: Black Powder Coat | Trim: Select finish options for Bevel and Flange separately: White, Black, Haze Silver					
GENERAL LISTINGS	ETL Listed. Damp Listed.					
CALIFORNIA TITLE 24	Registered CEC Appliance Database. Can be used to comply with CEC 2019 Title 24 Part 6 (JA8-2016, JA8-2019) (for 90 CRI versions).					
L70	50,000 hours min					
WARRANTY[2]	5 years					

Data in chart reflects 3000K/80CRI values unless noted. Lumen values are delivered lumens, not source lumens.
Custom Output/Custom RAL/Custom CCT available, Contact Quotes Department.
Ordering grids available on page 2.
[1]See ELEMENT-Lighting.com for dimmer compatibility.
[2]Visit ELEMENT-Lighting.com for specific warranty limitations and details.

UPDATED 3/4/22

TECH LIGHTING

ELEMENT™ 4" PRO SERIES LED

ADJUSTABLE DOWNLIGHT

ORDERING GRIDS

HOUSING

PRODUCT	CEILING APPEARANCE	OUTPUT	CRI/CCT	BEAM SPREAD	FUNCTION	HOUSING RATING	DRIVER	VOLTAGE
E4PR ELEMENT 4" PRO SERIES ROUND	**L** FLANGELESS	**-L08** 8W (675 LMS)[2]	**830** 80 CRI, 3000K, 2-STEP	**1** 18°	**A** ADJUSTABLE	**I** IC AIRTIGHT	**INTEGRATED DRIVERS 120V/277V**	(LEAVE BLANK) 120 VOLT
E4PS ELEMENT 4" PRO SERIES SQUARE	**F** FLANGED	**-L12** 12W (990 LMS)	**835** 80 CRI, 3500K, 2-STEP	**2** 25°		**N** NON-IC AIRTIGHT	UNIVERSAL PHASE/0-10V 1-5% (LEAVE BLANK)[6]	**-2** 277 VOLT
	WC WOOD CEILING[1]	**-L17** 17W (1350 LMS)	**840** 80 CRI, 4000K, 2-STEP	**4** 40°		**C** CHICAGO PLENUM	**-ELDO** ELDOLED 0.1% 0-10V LINEAR	
		-L24 24W (1800 LMS)	**927** 90 CRI, 2700K, 2-STEP	**6** 60°		**E** EMERGENCY BATTERY BACKUP (NON-IC AIRTIGHT/ CHICAGO PLENUM)[5]	**-ELDOA** ELDOLED 0.1% 0-10V LOGARITHMIC	
		-L29 29W (2430 LMS)	**930** 90 CRI, 3000K, 2-STEP				**-ELDD** ELDOLED 0.1% DALI	
		-L36 36W (2880 LMS)[3]	**935** 90 CRI, 3500K, 2-STEP				**-ELT0** ELDOLED TUNABLE WHITE 0.1% 0-10V LINEAR[4]	
			940 90 CRI, 4000K, 2-STEP				**-ELTD** ELDOLED TUNABLE WHITE 0.1% DALI[4]	
			WD31 90 CRI, 3000K-1800K, WARM DIM, 3-STEP				**-HLECO** LUTRON HI-LUME 0.1% ECOSYSTEM[7,8]	
			TW52 90 CRI, 5000K-2700K, TUNABLE WHITE, 2-STEP[4]				**INTEGRATED DRIVERS 120V**	
			TW41 90 CRI, 4000K-1800K, TUNABLE WHITE, 2-STEP[4]				**-HL2W** LUTRON HI-LUME 1% 2-WIRE[9]	
_____	_____	-	_____	_____	A	_____	_____	_____

Trims are required and must be ordered separately.
Output lists nominal wattage and lumens at 3000K/80CRI, actual wattage and lumens may vary slightly.
[1]WC - Wood Ceiling accommodates Flangeless trims only. For Flanged trims in a wood ceiling use standard Flanged housing.
[2]L08 - Dimming performance with standard UNIVERSAL PHASE/0-10V driver varies dramatically from <1% to >10% depending on the dimmer; please refer to Dimmer Compatibility chart.
[3]L36 - Output available Non-IC/CP only. Not available with HL2W and HLECO drivers. Not available with WD31 Warm Dim or TW52/TW41 Tunable White.
[4]TW52/TW41 - Tunable White available with ELTO (0-10V, linear) or ELTD (DALI) only. For 0-10V logarithmic dimming consult Quotes Department.
[5]E - Emergency Battery Backup Housing available in E4NGEMH Housing only.
[6]Universal dimming is reverse-phase, forward-phase, and TRIAC. The standard UNIVERSAL PHASE/0-10V driver dims to 1% with L12 and L17, and to 5% with L08, L24, L29 and L36. Dimming performance varies by dimmer; please refer to Dimmer Compatibility chart.
[7]HLECO - Lutron EcoSystem available IC only for L08, L12, and L17 output. Available with WD31 Warm Dim only for L12 and L17 output. Not available for L36 output.
[8]HLECO - Lutron has put their entire 0.1% ECO drivers on indefinite hold which impacts all -HLECO item numbers. Please consult factory for alternatives. This does not impact -HL2W.
[9]HL2W - Available IC only for L08, L12, and L17 output. Not available with WD31 Warm Dim for L08 output.

TRIM

PRODUCT	CEILING APPEARANCE	STYLE	FUNCTION	BEVEL FINISH	FLANGE FINISH
E4PR ELEMENT 4" PRO SERIES ROUND	**L** FLANGELESS	**R** REGRESS (1.0")	**A** ADJUSTABLE	**-W** WHITE	(LEAVE BLANK) FLANGELESS ONLY
E4PS ELEMENT 4" PRO SERIES SQUARE	**F** FLANGED			**-B** BLACK	
	F15 FLANGED 1.1"-1.5" CEILING THICKNESS			**-HS** HAZE SILVER	**W** WHITE
	F20 FLANGED 1.6"-2.0" CEILING THICKNESS				**B** BLACK
	F25 FLANGED 2.1"-2.5" CEILING THICKNESS				
_____	_____	R	A	-	_____

REPLACEMENT OPTICS

PRODUCT	BEAM SPREAD
353E4LEDCOPT	**18** 18°
	25 25°
	40 40°
	60 60°
353E4LEDCOPT	_____

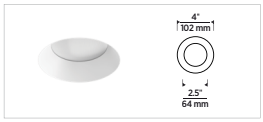
TECH LIGHTING

ELEMENT™ 4" PRO SERIES LED

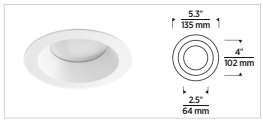
ADJUSTABLE DOWNLIGHT

TRIMS

ROUND

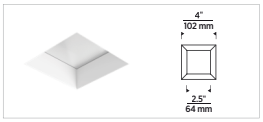


FLANGELESS

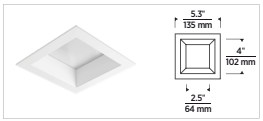


FLANGED

SQUARE



FLANGELESS



FLANGED

FINISH OPTIONS

NO FLANGE

HAZE SILVER BEVEL

BLACK BEVEL

WHITE BEVEL

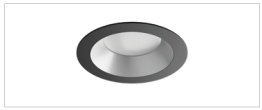
WHITE FLANGE

WHITE FLANGE, HAZE SILVER BEVEL

WHITE FLANGE, BLACK BEVEL

WHITE FLANGE, WHITE BEVEL

BLACK FLANGE



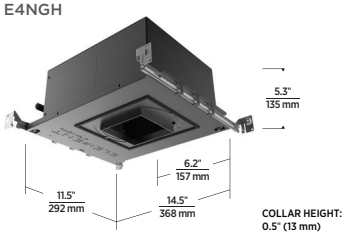
BLACK FLANGE, HAZE SILVER BEVEL

BLACK FLANGE, BLACK BEVEL

BLACK FLANGE, WHITE BEVEL

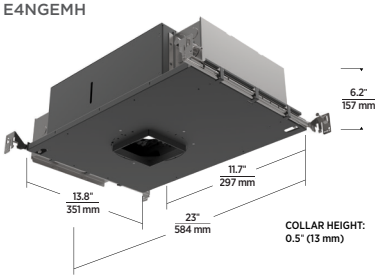
HOUSINGS

E4NGH



IC AIRTIGHT / NON-IC AIRTIGHT / CHICAGO PLENUM

E4NGEMH



EMERGENCY BATTERY BACKUP
(NON-IC / CHICAGO PLENUM)

4" SQUARE DIRECT

PICO SERIES

cylinders

C0455SQXT - CEILING MOUNT

APPLICATION

4" square x 5" high cylinder luminaire designed for general illumination.

FEATURES

Spectrum's Cylinder series provides traditional architectural style with high performance and energy efficient illumination. Rugged design with flexible mounting, finish and LED options make these extremely versatile fixtures. Integral LED driver. Quick change LED module for job site flexibility and fixture upgrade.

FINISH

Multi-stage polyester powder-coat process applied on our dedicated paint lines. See mounting and color pages for standard finishes. All exposed materials are chromate pretreated to resist corrosion. Cylinder housing and trim are same finish.

ELECTRONICS

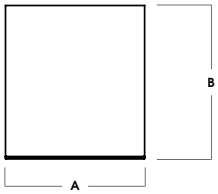
LED system features Xicato LED module with proprietary phosphor technology that provides consistent stable color with CCT control of +/- 100K over life of the light engine. Base CRI is 83 with 2-step MacAdam Ellipse binning. High CRI is 98 with 1 x 2-step MacAdam Ellipse binning. Variety of electronic 120V/277V and dimming drivers.

CONSTRUCTION

Fixtures are machined in our factory from 6063-H32 high purity aluminum extrusions. Specular primary optical reflectors provide high efficiency illumination. Stainless steel hardware with galvanized steel brackets to resist corrosion.

CODE COMPLIANCE

BAA compliant. ETL certified to meet US and Canadian standards. Suitable for dry or damp locations. Manufactured and tested to UL standards No. 1598/8750.



A	B
4.5 114.3 mm	5.0 127.0 mm

Fixture Weight: 5.5 lbs

LUMENS / WATTAGE DATA				
PART NUMBER	SOURCE LUMENS[1]	DELIVERED LUMENS[2]	SYSTEM WATTS[3]	LPW
C0455SQXT7L	700	526	6.2	85
C0455SQXT10L	1000	702	9.1	77

SERIES	LUMENS[1]		CCT		OPTICS		DRIVER / VOLTAGE[4]		OPTIONS[7]		MOUNTING[9]		FINISH[12]	
C0455SQXT	7L	700 Lm	83 CRI		XW	83°	EX	Electronic Driver, 120V/277V	FS	Fuse Holder and Fuse	HM[10]	Hang Straight	MW[13]	Matte White
	10L	1000 Lm	27K	2700K			DS10X	10%, 0-10V, 120V/277V	CR	Corrosion Resistant	PM[10]	Rigid Pendant Mount	MB[13]	Matte Black
			30K	3000K			DS2W1	ELV/MLV, 120V			AT[10]	Hang Straight All Thread	PT[13]	Platinum Silver
			35K	3500K			DMXS[5/6]	DMX Standard Configuration			CD[10/11]	Cord / Cable Mount	CC	Custom Color
			40K	4000K			DMXC[5/6]	DMX Non-Standard Custom			CM[10/11]	Cord Mount		
											SM	Surface Mount		
											CQD[6]	DMX Large Driver Canopy		
			98 CRI						LENS		EMERGENCY BATTERY OPTIONS		See Page 5 for Full Range of Color Options (83-90095)	
			27HK	2700K					SO[8]	Micro Prism Solite™ Lens	EMRM	7W Remote EM		
			30HK	3000K					GL	Clear Glass Lens	EMEN	7W Remote with Enclosure		
			35HK	3500K					FG	Frosted Glass Lens				
			40HK	4000K										

EXAMPLE: C0455SQXT10L35KXWEX/SO/SM/MW

NOTES:
1 Nominal Source Lumens at Any CCT **2** Nominal Delivered Lumens at 83 CRI at Any CCT with SO **3** At 83 CRI **4** Contact Factory for Additional Options **5** Contact Factory **6** CQD Required for DMXS/C **7** See Product Options Page for Details **8** Standard Lens for 83° Beam **9** See Mounting Page for Details on Components and Finishes **10** Specify Length in Inches: See Mounting Page for Available Lengths **11** EMxxxx Option Requires 2 Cords **12** See Color Page for More Options/Consult Factory for Special Finishes **13** Standard Finishes

SPECTRUM LIGHTING INC.

PROJECT:

TYPE:

5 YEAR WARRANTY

MADE IN THE USA

Dimensions and values shown are nominal. Spectrum Lighting continually works to improve products and reserves the right to make changes which may alter the performance or appearance of products.

4" SQUARE DIRECT

PICO SERIES / FIXTURE OPTIONS

cylinders

20 MAY 2022

ISSUED FOR PERMIT

B17 CHILD DAY-CARE CENTER

STANDARD FINISHES

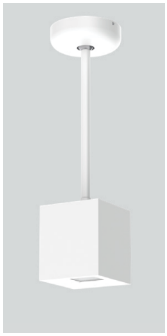
MW
MATTE WHITE

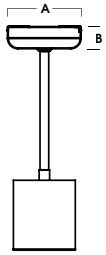
MB
MATTE BLACK

PT
PLATINUM SILVER

MOUNTING TYPES

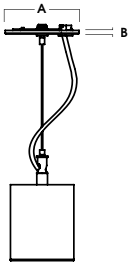
HM / PM / AT
HANG STRAIGHT / PENDANT / ALL THREAD





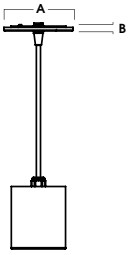
A	B
5.0 127.0 mm	1.5 38.1 mm

CD
CORD / CABLE MOUNT



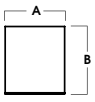
A	B
5.0 127.0 mm	.25 6.4 mm

CM
CORD MOUNT



A	B
5.0 127.0 mm	.25 6.4 mm

SM
SURFACE MOUNT



A	B
4.5 114.3 mm	5.0 127.0 mm

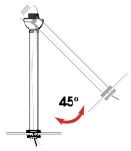
STANDARD MOUNTING & ACCESSORIES

SOME OPTIONS NOT AVAILABLE ON ALL FIXTURES, CONSULT SPECIFICATION SHEETS. SEE INDIVIDUAL SPECIFICATION SHEETS OR CONSULT FACTORY FOR ADDITIONAL INFORMATION.
NOTE: THIS IS TYPICAL OF CYLINDERS SPECIFICATION FOR PENDANT MOUNTING. INDIVIDUAL FIXTURES OR PROJECTS MAY HAVE SPECIALIZED REQUIREMENTS.

cylinders

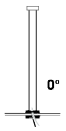
MOUNTING TYPES

HM*
HANG STRAIGHT
45° SWIVEL 5/8" OD STEM - 3/8" IP



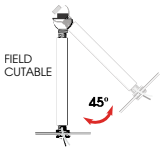
ORDER: **HM** (Length)
SPECIFY LENGTH:
HM3 - 3" **HM24 -** 24"
HM6 - 6" **HM36 -** 36"
HM12 - 12" **HM48 -** 48"
HM18 - 18" **HM72 -** 72"
HMLC(XX)
Custom Length
(Specify in Inches)

PM*
RIDGID PENDANT MOUNT
RIGID 5/8" OD STEM - 3/8" IP



ORDER: **PM** (Length)
SPECIFY LENGTH:
PM3 - 3" **PM24 -** 24"
PM6 - 6" **PM36 -** 36"
PM12 - 12" **PM48 -** 48"
PM18 - 18" **PM72 -** 72"
PMLC(XX)
Custom Length
(Specify in Inches)

AT**
HANG STRAIGHT ALL THREAD
45° SWIVEL 5/8" OD STEM - 1/4" IP



ORDER: **AT** (Length)
SPECIFY LENGTH:
AT12 - 12"
AT24 - 24"
AT36 - 36"

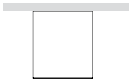
CD
CORD / CABLE MOUNT
SJ CORD WITH 1/16 SS CABLE

ORDER: **CD** (Length)
SPECIFY LENGTH:
CD36 - 36"
CD72 - 72"
CD144 - 144"
CDLC(XX)
Custom Length
(Specify in Inches)

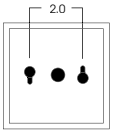
CM
CORD MOUNT
SJ CORD WITH STRAIN RELIEF

ORDER: **CM** (Length)
SPECIFY LENGTH:
CM36 - 36"
CM72 - 72"
CM144 - 144"
CMLC(XX)
Custom Length
(Specify in Inches)

SM
SURFACE MOUNT
WIRING COMPARTMENT / TOP HAT



ORDER: **SM**
TOP VIEW
CANOPY

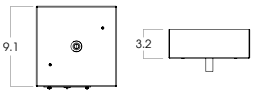


KEY SLOTS MOUNT CANOPY TO WALL JUNCTION BOX. JUNCTION BOX IS COVERED.

*MAXIMUM ONE PIECE STEM LENGTH IS 72". **MAXIMUM ONE PIECE STEM LENGTH IS 36".
LONGER LENGTHS ARE POSSIBLE USING MULTIPLE STEMS AND COUPLERS.

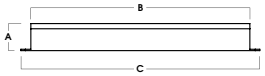
DMX OPTION

CQD - LARGE DRIVER CANOPY FOR DMX OPTIONS



REMOTE EMERGENCY BATTERY OPTIONS

EMRM* - 7W REMOTE EMERGENCY BATTERY (50' MAX)



A	B	C
1.3	12.6	13.0

EMEN* - 7W REMOTE EMERGENCY BATTERY WITH ENCLOSURE (50' MAX)

A	B	C
2.0	17.0	6.2

*OTHER EM BATTERY SIZES AVAILABLE, CONSULT FACTORY

4" SQUARE DIRECT

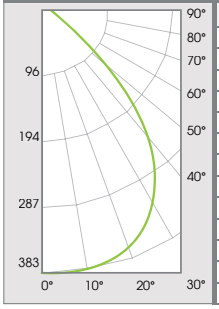
PICO SERIES / PHOTOMETRIC DATA

cylinders

C0455SQXT-10LxxK-XWEX-SOxxMW

10L XTRA WIDE - 83 CRI

CANDLEPOWER CURVE — **TEST: SP-00574_3**



Angle	CP at 0°
0	381
5	383
10	378
15	371
20	361
25	345
30	321
40	211
50	77
60	29
70	13
80	5
90	2

ZONAL LUMENS

0-10	36	5%
0-20	141	20%
0-30	300	43%
0-40	480	68%
0-60	667	95%
0-80	699	100%
0-90	702	100%
Total Lumens	702	100%

SINGLE UNIT: PERFORMANCE
INITIAL FOOTCANDLES AND BEAM ANGLE DIAMETERS

Mounting Height*	FC at Center	Diameter of Beam**	FC at Beam**
5.5'	13	9.7'	4
6.5'	9	11.4'	3
7.5'	7	13.2'	2
8.5'	5	15.0'	1
10.0'	4	17.6'	1
12.0'	3	21.1'	1
14.0'	2	24.6'	1
16.0'	1	28.2'	0

* From aperture to horizontal surface below.
** At IESNA defined Beam Angle, to 50% Max. CP.

Delivered Lumens: 702
Luminaire Watts: 9.1
LER: 77

CP @ 0° (Nadir): 381
Beam Angle: 82.7°
CRI: 83

Spacing Ratio: 1.24
Output Multipliers: 7L x 0.75

20 MAY 2022

ISSUED FOR PERMIT

B17 CHILD DAY-CARE CENTER

COLOR OPTIONS - POWDER COAT PAINT FINISHES

NOTE: NO PRINTED IMAGE CAN EQUAL THE EXACT COLOR OF FINISH ON METAL.
SEE INDIVIDUAL SPECIFICATION SHEETS OR CONSULT FACTORY FOR ADDITIONAL INFORMATION.

SPECTRUM POWDER COAT COLORS

STANDARD CORD / STEM / CANOPY FINISHES

FIXTURE COLOR	STANDARD CORD COLOR	STANDARD CANOPY / STEM COLOR
Matte White, Textured White	Matte White	Matte White
Gloss White	Matte White	Gloss White
Matte Black, Textured Black	Matte Black	Matte Black
All Others	Matte Black	Same Color as Fixture
Custom Color	Contact Factory	Contact Factory

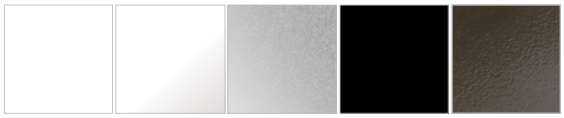
PAINT TIMES

TIER	COST	AVERAGE PAINT TIME*
Tier 1 - Standard Finishes	$	1
Tier 2 - Typical Finishes	$$	2
Custom Color	Contact Factory	Contact Factory

*CONTACT FACTORY FOR SPECIFIC PRODUCT LEAD TIMES

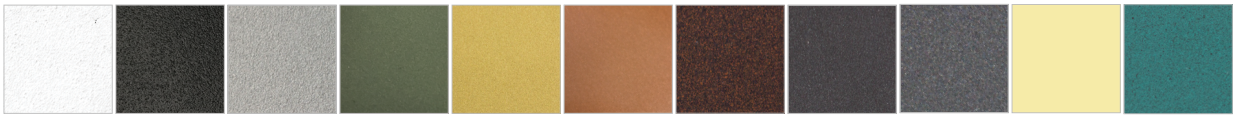
TIER 1 - STANDARD FINISHES

MW Matte White
GW Gloss White
PT Platinum Silver
MB Matte Black
BZ Bronze



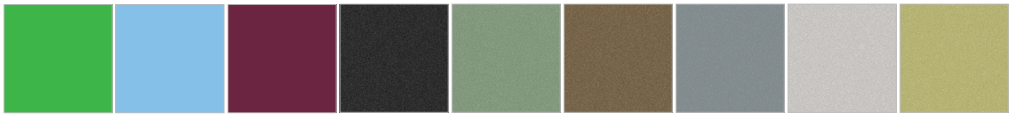
TIER 2 - TYPICAL FINISHES

TW Textured White
TB Textured Black
MT* Textured Silver
OB* Oil Rubbed Bronze
SN Sun Gold
CO Copper Metallic
BR Brecchia
GH Graphite
CH Charcoal
AL Almond
VE Verde Green



BL Blue Streak
RD Red Baron
OR Orange
CM Camel
PL Purple
PG Pub Green
TQ Turquoise
SF Sea Foam
PK Pink
AY Aero Yellow
EG Evergreen

LG Lime Green
LB Light Blue
BY Burgundy
AK Anodic Black
AM Anodic Malachite
AZ Anodic Bronze
AS Anodic Sapphire
AN Anodic Natural
AC Anodic Champagne



CUSTOM COLOR FINISHES

CONTACT FACTORY

CC
Custom Color

*UNAVAILABLE FOR WET LOCATION

MILO PENDANT

TECH LIGHTING

PRODUCT FEATURES

- Vibrant twist on the early twentieth century factory light
- Moderately scaled ideal for a wide range of lighting applications
- Available in invigorating color combinations
- Ideal for kitchen island task lighting, hallway lighting and dining room lighting
- Fully dimmable lamping options create the desired ambiance in your unique space
- Protected by a 5-year warranty if LED lamping option is chosen. Protected by a 1-year warranty if non-LED lamping option is chosen

White/Champagne

Gray/Chartreuse White/Champagne White/Orange

LAMPING

Rated for 100 watt max. E26 medium Base lamp (Lamp Not Included). LED includes one E26 medium base A19 9.5 watt 400 delivered lumen 90 CRI 2700K LED lamp. LED dimmable with most LED compatible ELV or Triac dimmers. Includes 12' of field-cuttable cord.

ORDERING INFORMATION

700TDMLO	COLOR	LAMP
	GC GRAY OUTSIDE/CHARTREUSE INSIDE	NO LAMP
	WM WHITE OUTSIDE/CHAMPAGNE INSIDE	**-LED927** A19 LED 90 CRI 2700K 120V (T20/T24)
	WO WHITE OUTSIDE/ORANGE INSIDE	

700TDMLO _____ _____
JOB NAME _____
NOTES _____
_____

7400 Linder Avenue, Skokie, IL 60077
T 847.410.4400 | F 847.410.4500 | techlighting.com

20 MAY 2022

ISSUED FOR PERMIT

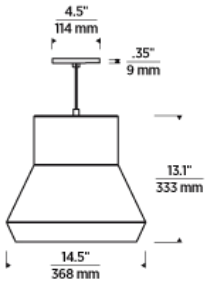
B17 CHILD DAY-CARE CENTER

MILO PENDANT

TECH LIGHTING

SPECIFICATIONS

HARDWARE MATERIAL	Metal
SHADE MATERIAL	
NET WEIGHT	7 lbs
HEIGHT	13.1in
WIDTH	14.5in
LENGTH	14.5in
UP LIGHT / DOWN LIGHT / BOTH?	
WET LISTED	
DAMP LISTED	Yes
DRY LISTED	
MIN. HANGING HEIGHT	20in
MAX HANGING HEIGHT	157in
TOTAL CORD LENGTH	144in
TOTAL STEM LENGTH	
STEM QTY	
SLOPED CEILING ADAPTABLE?	Yes 45° Max
GENERAL LISTING	ETL Listed
INCLUDES	



LAMPING SPECIFICATIONS

	LED LAMP	INTEGRATED LED	NON LED	NO LAMP
DELIVERED LUMENS	400			
WATTS	9.5			
MAX WATTAGE PER BULB	100W		100W	
INPUT VOLTAGE	120V		120V	
DIMMING TYPE*	ELV, TRIAC		ELV, TRIAC	
CCT	2700K			
CRI	90 CRI			
LED LIFETIME				
L70	>25000			
AVERAGE BULB HOURS				
FIELD SERVICEABLE LED				
LAMP BASE	E26 Medium Base		E26 Medium Base	
LAMP SHAPE	A19		A19	
LAMP INCLUDED?	True		False	
WARRANTY**	1 Year		1 Year	

* Dimming information available at www.techlighting.com/Downloads#dimming
** Visit techlighting.com for specific warranty limitations and details.

T20 / T24 / JA8 INFORMATION

	Integrated LED	Replacement LED Lamp	No Lamp *
This product can be used to comply with California Building Energy Efficiency Standards 2016 **Title 24** Part 6 / **JA8**.		Yes	N/A
This product can be used to comply with California Appliance Efficiency Standards 2016 **Title 20** and may be shipped to and sold in California.		Yes	N/A

* If a light fixture or component does not include a lamp or light source, it is the responsibility of the customer to select a lamp that meets the T24 and T20 requirements.

7400 Linder Avenue, Skokie, IL 60077
T 847.410.4400 | F 847.410.4500 | techlighting.com

DIA 2x4 LED | Recessed T-Bar & Drywall

Project _____

Type _____

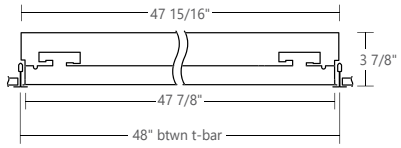
Notes _____

_____

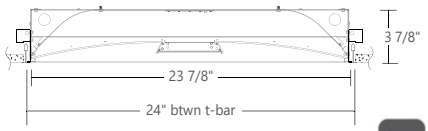
PERFORMANCE AT 4000K

NOMINAL LUMEN OUTPUT	INPUT WATTS*	EFFICACY
3100 lm	31 W	100 lm/W
4500 lm	38.37 W	117 lm/W
5000 lm	44 W	114 lm/W
7000 lm	62.76 W	112 lm/W
9000 lm	81.36 W	111 lm/W

* Based on a 2'x4' luminaire using one driver
Please consult factory for custom lumen output and wattage.



SIDE VIEW



SECTION VIEW

See page 2 for DLC Approved options

Axitune Dim-to-Warm · Axitune Tunable White · PoE · Control Sensors · cULus Listed Type I.C.

Ordering Guide

DIALED																	
PRODUCT ID		**SIZE**		**NOMINAL LUMENS**		**CRI**		**COLOR TEMP. (choose one)**						**SHIELDING**		**FINISH**	
DIALED	DIA LED	**24**	2'X4'	**1400**	1400 lm - Min	**80**	80 CRI	**27**	2700 K	**TW2750**	2700-5000 K - Tunable White			**VL**	VL optics	**W**	white
				6400	6400 lm - Max at 90 CRI	**90**	90 CRI*	**30**	3000 K	**TW2765**	2700-6500 K - Tunable White					**C**	custom
				7200	7200 lm - Max at 80 CRI			**35**	3500 K	**BTW3527**	3500-2700 K - Tunable BIOS						
								40	4000 K	**BTW4027**	4000-2700 K - Tunable BIOS						
								B30	3000 K - BIOS*	**DW3020**	3000-2000 K - Dim to Warm						
								B35	3500 K - BIOS*								
								B40	4000 K - BIOS*								
				Outputs between listed min and max are available. Consult factory for outputs outside of the listed range Consult factory for max output with BIOS.		*Not available with BIOS.		Consult Axitune technical sheet for more information of color technology *Consult BIOS guide for more information on BIOS technology									

VOLTAGE		DRIVER		CIRCUITS		MOUNTING		BATTERY (OPTIONAL)	
120	120 V	**DP**	dimming (0-10V) 1%	**1**	1 circuit	**TB9**	t-bar 9/16"	**B(#)**	battery pack
277	277 V	**LT(#)**	lutron *	**+E(#)**	emergency circuit *	**TB15**	t-bar 15/16"		
347	347 V	**BI**	bi-level dimming	**+NL(#)**	night light circuit *	**ST**	screw slot t-bar		
UNV	universal	**O(#)**	other **	**+GTD(#)**	generator transfer device *	**TG9**	tegular 9/16"		
DC	low voltage*	**DPB(STC)**	dimming (0-10V) 1% with BIOS*			**TG15**	tegular 15/16"		
		DPB(DYN)	Bio-dimming™ 100%-81% with BIOS*			**DF**	drywall flange		
		TW(#)	tunable white drivers*						
		POE(#)	POE drivers*						
* Only available with POE drivers		*See page 2 to specify system **Please consult factory; see page 2 Consult factory for other control options.		* Specify quantity				Not available with 347V Please consult factory	

OTHER (OPTIONAL)		IC CONTROLS (OPTIONAL)		CUSTOM (OPTIONAL)	
F	fuse *	**DS(#)**	daylight sensor	**C**	custom
FW(#)	flex whip (6' std)	**OS(#)**	occupancy sensor		
AR	air return	**DOS(#)**	daylight & occupancy sensor		
CP	Chicago plenum	**EN(#)**	Enlighted integral *		
		ENR(#)	Enlighted remote *		
		WC(#)	wireless control dimming		
* Requires 120V or 277V Not available with 347V.		* Please consult factory Specify quantity. Requires 1.5" blank. See integrated controls guide for more details. Consult factory for Tunable White. Not available with DPB (DYN) driver for BIOS with Dynamic Spectrum.		Please specify	

SPECIFY DRIVER NAME (if needed)

SPECIFY BATTERY NAME (if needed)

1.800.263.2947
[T] 514.948.6272
axislighting.com

Cosentini A TETRA TECH COMPANY

DIA 2x4 LED | Recessed T-Bar & Drywall

SPECIFICATIONS

Housing	Die formed cold rolled sheet steel (20 gauge)
Central Lens Housing	Extruded aluminum (0.060" nominal)
Center Lens	PMMA Precision formed microconical structure 92 percent transmission, cuts off glare above 55^0 .
Side lens	0.08" PMMA satin blend
Reflectors	Die formed cold rolled sheet steel (22 gauge)
Interior Brackets	Die formed cold rolled sheet steel (20 gauge)
Drywall Flange Kit	Extruded aluminum (0.060" nominal)

ELECTRICAL

Lutron driver*	**LDE1** - Hi-lume 1% EcoSystem with Soft-on, Fade-to-Black **LTEA** - Hi-lume 1% 2-wire (120V forward phase only) *Consult factory
Other drivers**	**DALI** - Digital Addressable Lighting Interface **DMX** - Digital Multiplex **LV** - line voltage - Advance Mark 10 **Xitanium SR** - For wireless sensor
BIOS DPB drivers*	**STC** - BIOS control 0-10V with static spectrum and BIOS SkyBlue enabled from 100% to 1%. **DYN** - BIOS control 0-10V with dynamic spectrum and BIOS SkyBlue® with Bio-Dimming™, which changes spectral qualities by removing the SkyBlue component when dimming from 100% to 81%, while light output remains relatively constant; bio-dimming reduces CCT to 2700K. Dimming from 80% to 1% will then reduce light output.
Tunable White TW drivers*	**DALIDT6** - DALI Type 6 (Two DALI Addresses) **DALIDT8** - DALI Type 8 (One DALI Address) **LTTW** - Lutron T-Series Tunable White
Power over Ethernet POE drivers* UL2108 certified for integral or remote driver	MOLEX IGOR **O** - Other (Consult factory)
Emergency	Integral emergency battery pack or emergency circuit optional.
Input Voltage	120V, 277V, 347V, UNV, DC.
Flex Whip	Shipped in a separate box for contractors to install

***Choose driver from available options.**

Incorporating these components may have limitations or affect the length of the luminaire. Please contact factory for more details.

DLC Approved Options

*Check the latest update on the DLC website for complete information. Not all versions may be DLC qualified.

SIZE	OUTPUT	CRI	LUMENS	SHIELDING	FINISH	VOLTAGE	DRIVER	CIRCUITS
2'X4'	3100 lm 4500 lm 5000 lm 7000 lm	80	3000 K 3500 K 4000 K	VL	white	universal	DP	1

WARRANTY

Axis Lighting will warrant defective LEDs, boards, and drivers for 5 years from date of purchase. Warranty is valid if luminaire is installed and used according to specifications.
If defective, Axis will send replacement boards or drivers at no cost along with detailed replacement instructions and instructions on how to return defective components to Axis.

APPROVALS

Certified to UL and CSA standards
Chicago Plenum Certified (CCEA)
Meets NYC requirements
Suitable for damp locations.
IC Rated (Insulated ceiling)

WEIGHT

Standard	19 lbs / 8.6 kg
Drywall with Kit	21 lbs / 9.6 kg

FINISH

Highly reflective, matte powder coat white paint for high efficiency. Matte texture to diffuse glare and lamp image on the surface within the optical chamber exterior. Custom finishes are also available.

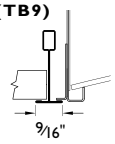
1.800.263.2947
[T] 514.948.6272
axislighting.com

DIA 2x4 LED | Recessed T-Bar & Drywall

CEILING SYSTEM

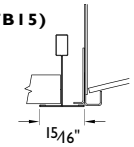
T-BAR STYLE MOUNTING

(TB9)



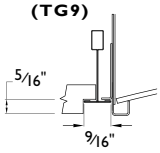
9/16" T-BAR

(TB15)



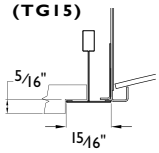
15/16" T-BAR

(TG9)



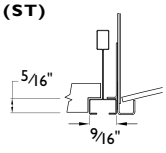
9/16" TEGULAR

(TG15)



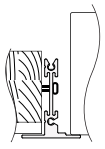
15/16" TEGULAR

(ST)

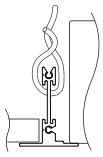


SCREW SLOT

DRYWALL WITH FLANGE KIT (DF)

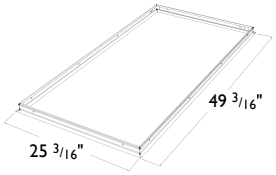


WITH WOOD FRAME



WITHOUT WOOD FRAME

DRYWALL MOUNTING KIT



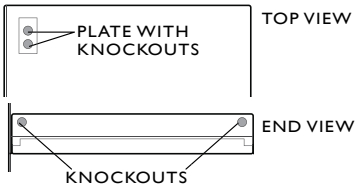
FIXTURE DIMENSIONS
47 3/8"/23 3/8"

CUT HOLE DIMENSIONS
48 7/16"/24 7/16"

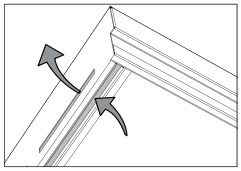
Installation sheets for all mounting options are available at: www.axislighting.com

STANDARD AND END MOUNT POWER FEED

Knockouts for BX cable connection are provided both on the top and on the ends of the luminaire. This allows for an end mount power feed solution if it is required.
(BX CABLE BY OTHERS)



AIR RETURN



The air return (AR) option consists of discrete slots along the sides of the luminaire. These slots allow air to exhaust into the plenum and eliminate the need for unsightly air return grilles, and create a clean and well organized ceiling.

LED SYSTEM

CRI	Minimum 80 or 90 color rendering index.
CRI BIOS	Minimum 80 color rendering index with R9>75 for all CCTs.
CCT Single Color	Choice of 2700K, 3000K, 3500K and 4000K color temperature with a great color consistency (within 3–step MacAdam ellipse). Both within fixture and fixture to fixture.
CCT BIOS	BIOS Static (STC) Choice of 3000K, 3500K and 4000K. BIOS SkyBlue® Dynamic (DYN) Choice of 3000K, 3500K, and 4000K with Bio-Dimming™ BIOS Tunable White (BTW) Choice of 4000-2700K and 3500-2700K; does not use a bio-dimmer, it uses TW drivers, which allow independent control of CCT and intensity; e.g., BTW4027 provides combined SkyBlue + white light at 4000K, SkyBlue is removed at 2700K. Light output can be adjusted for each CCT. Consult BIOS guide for more information on BIOS technology.
CCT Axitune Systems	Consult Axitune technical sheet for more information on color technology.
LED life	Minimum 50,000h with 85% of lumen maintenance in 25°C ambient temperature, in compliance with IES LM-80 testing measurements.
Thermal Management	Aluminum housing acting as the heat sink to maximize life.
Environment	Dry and damp rated in operating ambient temperatures of 0-40°C (32-104F).

PO number: _____ Signature: _____

T-BAR LED Block Clear Diffusing Lens | Order Specification Guide

T-BAR LED®

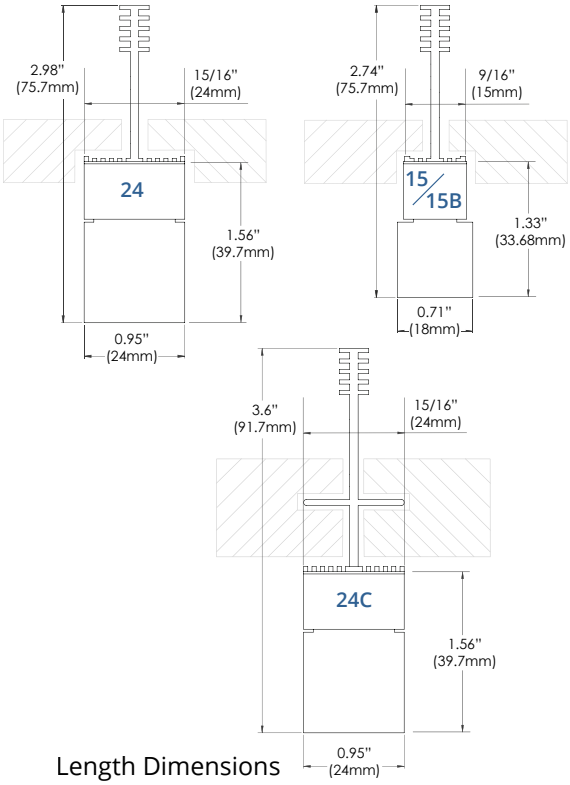
Product Name	Type of LED/K Color	Size	Grid Type	Optic	Mounting Clips	Color	Options
☐ TBSL = T-BAR LED	☐ HW = 3000K ☐ MW = 3500K ☐ MN = 4000K ☐ HN = 4500K ☐ TU = 2700–5000K tunable	☐ 2 = 2 ft ☐ 4 = 4 ft ☐ 5 = 5 ft ☐ 4L = 4 ft L ☐ 6 = 60 cm ☐ 12 = 120 cm ☐ 12L = 120 cm L	☐ 24 = 15/16” ☐ 15 = 9/16” ☐ 15B = 9/16” Bolt Slot ☐ 24C = 15/16” Partially Concealed Grid	☐ B = Block Clear Diffusing Lens	☐ U = Universal ☐ A = Armstrong ☐ C = Custom	☐ W = White ☐ C = Custom	☐ CP = Chicago Plenum rated ☐ IP65 = IP65 rated ☐ POE = Power over Ethernet*

www.jlc-tech.com/patents

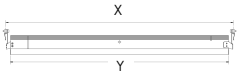
*Consult factory for POE

Profile Dimensions

(Compatible with Tegular and Lay-in tiles)



Length Dimensions

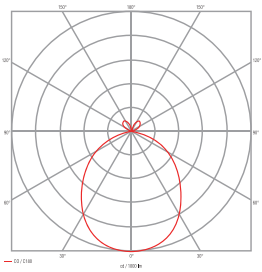


Size	Grid Type	X	Y
2 = 2ft	24 = 15/16”	24”	23”
4 = 4ft	24 = 15/16”	48”	47”
5 = 5ft	24 = 15/16"	60”	59”
4L = 4ft L	24 = 15/16”	48”	24”
2 = 2ft	15 = 9/16”	24”	23.4”
4 = 4ft	15 = 9/16”	48”	47.4”
5 = 5ft	15 = 9/16”	60”	59.4”
4L = 4ft L	15 = 9/16"	48”	24”

CRI = >82 L_{80} > 60K hrs IP40

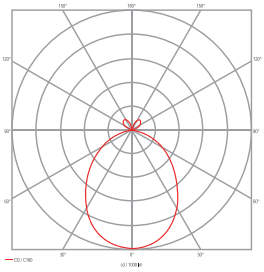
LIGHT OUTPUT:

15/16” - 564lm per foot
72lm/W



15/16” Block Clear Diffusing Lens

9/16” - 438lm per foot
56lm/W



9/16” Block Clear Diffusing Lens

NOTES:

T-BAR LED modules can be parallel connected up to 12 linear feet max per power supply. Remote power supply includes JB compartment for AC input direct wiring with metal conduit. Max distance from power supply to fixtures is 30 feet with 18 AWG wire. Longer distance achievable if using higher gauge wire. Color filters and/or special acrylic sizes available on request, consult factory. IP65 and Chicago Plenum optional ratings available, (see page 19).

APPLICATIONS:

Executive, Medical, Health, Educational, Retail, Hotels, Airport, Hospitality and any open space areas that require a unique and elegant architectural lighting design.

MOUNTING:

Universal mounting brackets are for easy installation to standard 15/16” or 9/16” T-Bars of most manufacturers’ ceiling suspension systems.Armstrong compatible mounting clips for installation with Armstrong Ceiling 15/16” Prelude® and Clean Room™, 9/16” Suprafine®, Silhouette®, Sonata® and Interlude® suspension systems. Compatible with Tegular and Lay-in tiles.

MATERIALS:

Anodized and painted aluminum extruded body, steel mounting clips, white PC end caps, high transmitting acrylic PMMA lens.

ELECTRIC:

High output LEDs consume 16W total (2 foot) or 32W total (4 foot) or 40W total (5 foot). Power supply consumption not included. Input voltage 24VDC. Class 2 plenum rated cables at each end equipped with quick connectors to allow multiple modules to be easily connected together (max 12 linear feet of product). Use solid copper wire or wire ferrules to fit into quick connectors. POE options available, consult factory.

WARRANTY:

5 years

LISTINGS:

ETL/cETLus CE RoHS. Indoor use only. IC Rated.

hpd VERSION 2.2

MADE IN USA

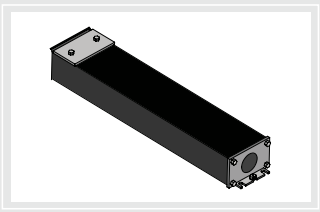
PO number: _____ Signature: _____

T-BAR LED Remote Drivers | Order Specification Guide

T-BAR LED® T-BAR UP®

Product Name	Driver Type	Power	Wattage	Voltage
☐ TBSL = T-BAR LED Power Supply	☐ PS = Non Dimmable ☐ DIM = 1% Dimmable 0-10 VDC	☐ HP = High Power	☐ 100W = 96W ☐ 200W = 192W ☐ 400W = 384W	☐ UNV = Universal 100-277V

WARRANTY: **5 years**

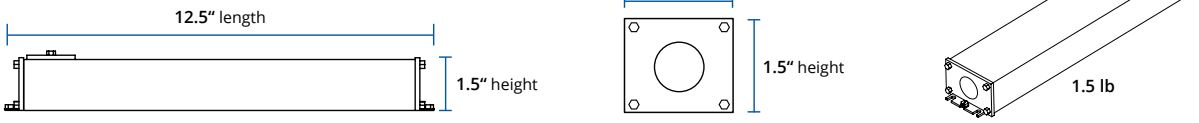


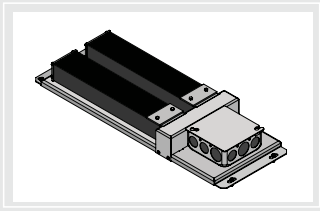
24VDC LED Driver 96W Power Supply

0-10 VDC dimmable and non dimmable

T-BAR LED and T-BAR UP modules can be parallel connected up to 12 linear feet max per power supply. Power supply includes JB compartment for AC input direct wiring with metal conduit.

96W Power Supply dimensions



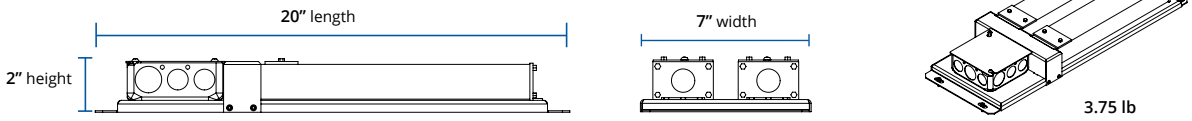


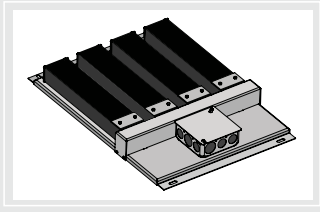
24VDC LED Driver 192W Power Supply

0-10 VDC dimmable and non dimmable

T-BAR LED and T-BAR UP modules can be parallel connected up to 12 linear feet max per channel totaling 24 linear feet of illuminated product. Power supply includes JB compartment for AC input direct wiring with metal conduit.

192W Power Supply dimensions



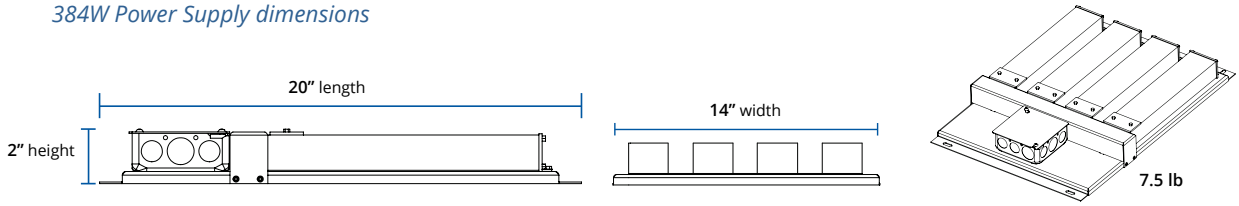


24VDC LED Driver 384W Power Supply

0-10 VDC dimmable and non dimmable

T-BAR LED and T-BAR UP modules can be parallel connected up to 12 linear feet max per channel totaling 48 linear feet of illuminated product. Power kit includes JB for AC input direct wiring with metal conduit.

384W Power Supply dimensions



JUNO

Project:

Fixture Type:

Location:

Contact/Phone:

JUNO SLIMFORM™ LED SURFACE MOUNT DOWNLIGHTS

FOR J-BOX INSTALLATION

5", 7", 12", 14" SQUARE

JSFSQ SERIES

PRODUCT DESCRIPTION

Sleek, ultra-low profile energy efficient LED surface mount downlights in multiple sizes from 5" to 14" • Provides economical installation by mounting directly over standard and fire-rated junction boxes • Optional finish trims and shrouds available for custom, designer look similar to standard recessed downlights • Provides general illumination in residential and commercial applications including multi-family and hospitality • Ideal for use in corridors, living spaces, closets, hallways, pantries, stairways, outdoor covered areas without Emergency Option and much more.

PRODUCT SPECIFICATIONS

Construction Shallow, less than 1", solid square housing with white finish • Non conductive fixture for shower light applications • Optional, field installable finish trims available for 5" and 7" versions to change the exterior finish of fixture • Optional, field installable decorative baffle and cone shrouds for 5" and 7" versions provide the aesthetic and source shielding similar to the experience of a fully recessed downlight.

Optics Light quide technology combined with diffusing lens conceals the LEDs from direct view and provides uniform lens luminance.

LED Light Engine LEDs mounted directly to heatsink designed to provide superior thermal management and ensure long life • 2700K, 3000K, 3500K or 4000K LED color temperature • LEDs binned for 4-step MacAdam ellipse color consistency • 90 CRI minimum.

LED Driver Choice of dedicated 120 volt (120) driver or universal voltage (MVOLT) driver that accommodates input voltages from 120-277 volts AC at 50/60Hz • Power factor > 0.9 at 120V input •120 volt driver is dimmable with the use of most incandescent, magnetic low voltage and electronic low voltage wall box dimmers • Universal voltage driver is dimmable with the use of most 0-10V wall box dimmers • External driver on 5" and 7" models only • For a list of compatible dimmers, see JUNOSLIMFORM-DIM.

Emergency Battery Option Available on fixture sizes 12" and larger • Battery factory assembled to fixture with integral test switch (EL option) • Drives LEDs for 90 minutes to meet Life Safety Code (NFPA-LSC), National Electrical Code (NEC), and UL requirements • Title 20 certified battery pack available when ordering E10WLCP option • EBX option provides back box without battery for consistent look when used in same space as fixtures with EL emergency option • Damp location only with emergency option.

Life Rated for 50,000 hours at >70% lumen maintenance.

Labels ENERGY STAR® certified • Certified to the high efficacy requirements of California T24 JA8-2016 • CSA listed for US and Canada • Suitable for wet locations (covered ceilings) • Damp location only with emergency option.

Testing All reports are based on published industry procedures; actual performance may differ as a result of the end-user environment and applications. All values are design or typical values, measured under laboratory conditions at 25 °C.

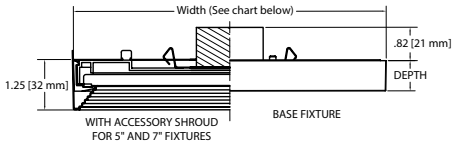
Warranty 5-year limited warranty. This is the only warranty provided and no other statements in this specification sheet create any warranty of any kind. All other express and implied warranties are disclaimed. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note: Actual performance may differ as a result of end-user environment and application.

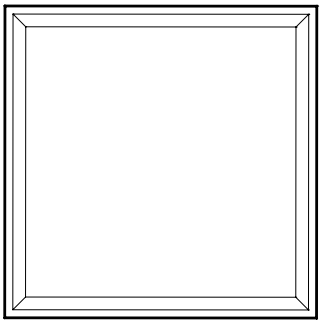
All values are design or typical values, measured under laboratory conditions at 25 °C.

Specifications subject to change without notice.

DIMENSIONS



External driver available on 5" and 7" models only.



SQUARE SPECIFICATIONS

	Width	Depth
JSFSQ 5IN	5.25 (13.34)	0.75 (1.91)
JSFSQ 7IN	7.77 (19.74)	0.75 (1.91)
JSFSQ 12IN	12.07 (30.66)	0.9 (2.29)
JSFSQ 14IN	14.18 (36.02)	0.9 (2.29)

All dimensions are in inches (centimeters) unless otherwise indicated.

INSTALLATION

Junction Box Mounting Fixture provided with leads for direct wire connection in j-box • Installs directly to industry standard junction boxes

• Compatible boxes include 4" metal or plastic octagonal standard and

fire-rated junction boxes (3 1/2" junction box screw-hole spacing required for installation) • Minimum 2 1/8" deep junction box required for 5" and 7" fixtures (no depth requirement for 12" and larger fixtures) • Quick mount bracket provides fast installation of fully assembled fixture to junction box

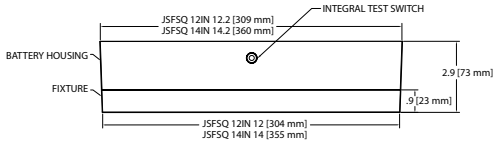
• Suitable for ceiling mount • Suitable for use within closet storage spaces when installed per NEC requirements.

Junction box sizes vary - Verify compatibility with fixture prior to installation

JUNO SLIMFORM™ LED SURFACE MOUNT DOWNLIGHTS

FOR J-BOX INSTALLATION
5", 7", 12", 14" SQUARE
JSFSQ SERIES

EMERGENCY BATTERY FOR 12" AND 14" ONLY



PERFORMANCE DATA

	JSFSQ 5IN		JSFSQ 7IN		JSFSQ 12IN		JSFSQ 14IN	
	120V	**MVOLT**	**120V**	**MVOLT**	**120V**	**MVOLT**	**120V**	**MVOLT**
Lumens	700	700	1000	1000	1300	1300	1800	1800
CRI	90CRI		90CRI		90CRI		90CRI	
CCT	27K, 30K, 35K, 40K		27K, 30K, 35K, 40K		27K, 30K, 35K, 40K		27K, 30K, 35K, 40K	
Voltage	120V	120V-277V	120V	120V-277V	120V	120V-277V	120V	120V-277V
Input Power	10W	10W	13W	13W	15W	15W	20W	20W
Input Current	110MA	50MA	150MA	60MA	180MA	80MA	240MA	110MA
Frequency	50/60Hz		50/60Hz		50/60Hz		50/60Hz	
Power Factor	>0.9		>0.9		>0.9		>0.9	

ORDERING INFORMATION

Example: JSFSQ 5IN 07LM 27K 90CRI 120 FRPC WH

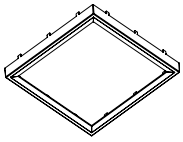
Series	Size/Lumens	Color Temperature	CRI	Voltage/Driver	Finish	Emergency Battery[1,2,3]
JSFSQ SlimForm Surface Mount Downlight - Square	5IN 07LM 5", 700 Lumens 7IN 10LM 7", 1000 Lumens 12IN 13LM 12", 1300 Lumens 14IN 18LM 14", 1800 Lumens	27K 2700K 30K 3000K 35K 3500K 40K 4000K	90CRI 90+ CRI	120 FRPC Dedicated 120V, Forward Reverse Phase Dimmnig MVOLT ZT Universal Voltage 120V-277V, 0-10V Dimming	WH White	EL[3†] Battery Back-up Option EBX Empty Back Box for Aesthetics E10WLCP[4†] EM Self-Diagnostic battery pack, 10W Constant Power, Certified in CA Title 20 MAEDBS.

†: EL Battery Back-up option is not Energy Star certified

ACCESSORIES

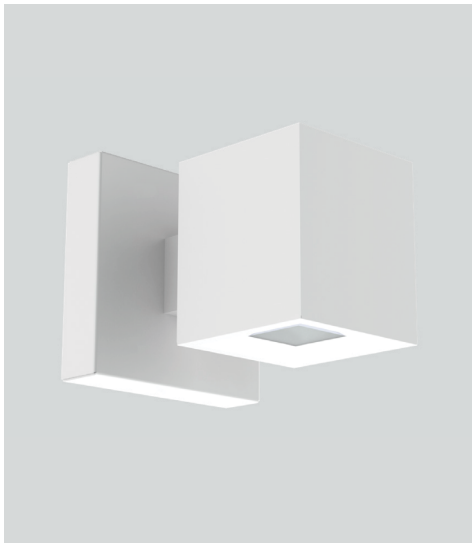
TRIM – Optional, field installable finish trim rings available to change the exterior finish of fixture.
Example: JSFSQTRIM 5IN BL

Series	Size	Finish
JSFSQTRIM SlimForm Accessory Trim - Square	5IN 5 inches 7IN 7 inches	BL Black BZ Bronze SN Satin Nickel



TRIM

Notes:
1 Emergency battery available with 12IN and 14IN only.
2 Emergency battery is only available with MVOLT ZT.
3 Emergency battery option not available in California due to Title 20 restrictions.
4 E10WLCP ordering option is Title 20 certified for shipments to California.



4" SQUARE DIRECT

PICO SERIES

cylinders

C0455SQXT - WALL MOUNT

APPLICATION

4" square x 5" high cylinder luminaire designed for general illumination.

FEATURES

Spectrum's Cylinder series provides traditional architectural style with high performance and energy efficient illumination. Rugged design with flexible mounting, finish and LED options make these extremely versatile fixtures. Integral LED driver. Quick change LED module for job site flexibility and fixture upgrade.

FINISH

Multi-stage polyester powder-coat process applied on our dedicated paint lines. See mounting and color pages for standard finishes. All exposed materials are chromate pretreated to resist corrosion. Cylinder housing and trim are same finish.

ELECTRONICS

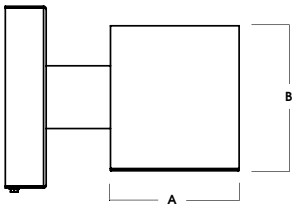
LED system features Xicato LED module with proprietary phosphor technology that provides consistent stable color with CCT control of +/- 100K over life of the light engine. Base CRI is 83 with 2-step MacAdam Ellipse binning. High CRI is 98 with 1 x 2-step MacAdam Ellipse binning. Variety of electronic 120V/277V and dimming drivers.

CONSTRUCTION

Fixtures are machined in our factory from 6063-H32 high purity aluminum extrusions. Specular primary optical reflectors provide high efficiency illumination. Stainless steel hardware with galvanized steel brackets to resist corrosion.

CODE COMPLIANCE

BAA compliant. ETL certified to meet US and Canadian standards. Suitable for dry or damp locations. Manufactured and tested to UL standards No. 1598/8750.



A	B
4.5 114.3 mm	5.0 127.0 mm

Fixture Weight: 5.7 lbs

LUMENS / WATTAGE DATA				
PART NUMBER	SOURCE LUMENS[1]	DELIVERED LUMENS[2]	SYSTEM WATTS[3]	LPW
C0455SQXT7L	700	526	6.2	85
C0455SQXT10L	1000	702	9.1	77

SERIES	LUMENS[1]		CCT		OPTICS		DRIVER / VOLTAGE[4]		OPTIONS[5]		MOUNTING[7]		FINISH[8]	
C0455SQXT	7L	700 Lm	83 CRI		XW	83°	EX	Electronic Driver, 120V/277V	FS	Fuse Holder and Fuse	WM3	Wall Mount 3" Extension	MW[9]	Matte White
	10L	1000 Lm	27K	2700K			DS10X	10%, 0-10V, 120V/277V	CR	Corrosion Resistant			MB[9]	Matte Black
			30K	3000K			DS2W1	ELV/MLV, 120V					PT[9]	Platinum Silver
			35K	3500K									CC	Custom Color
			40K	4000K										
			98 CRI						LENS		EMERGENCY BATTERY OPTIONS		See Page 4 for Full Range of Color Options (83-90095)	
			27HK	2700K					SO[6]	Micro Prism Solite™ Lens	EMRM	7W Remote EM		
			30HK	3000K					GL	Clear Glass Lens	EMEN	7W Remote with Enclosure		
			35HK	3500K					FG	Frosted Glass Lens				
			40HK	4000K										

EXAMPLE: C0455SQXT10L35KXWEX/SO/WM3/MW

NOTES:
1 Nominal Source Lumens at Any CCT **2** Nominal Delivered Lumens at 83 CRI at Any CCT with SO **3** At 83 CRI **4** Contact Factory for Additional Options **5** See Product Options Page for Details
6 Standard Lens for 83° Beam **7** See Mounting Page for Details on Components and Finishes **8** See Color Page for More Options/Consult Factory for Special Finishes **9** Standard Finishes

SPECTRUM LIGHTING INC.

PROJECT:

TYPE:

5 YEAR WARRANTY

MADE IN THE USA

4" SQUARE DIRECT

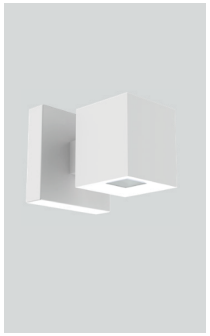
PICO SERIES / FIXTURE OPTIONS

cylinders

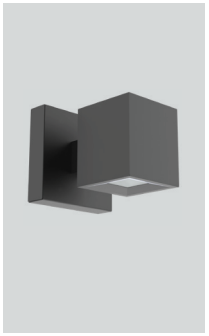
20 MAY 2022

STANDARD FINISHES

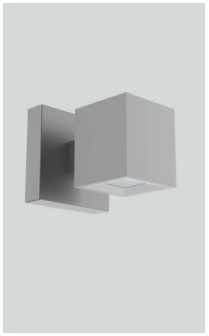
MW
MATTE WHITE



MB
MATTE BLACK

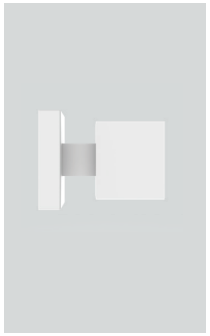


PT
PLATINUM SILVER

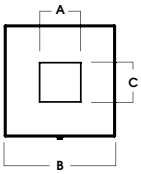


WALL MOUNT DETAIL

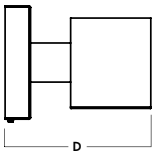
WM3
WALL MOUNT 3" EXTENSION



FRONT VIEW



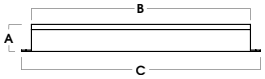
SIDE VIEW



A	B	C	D
1.4 35.6 mm	6.4 162.6 mm	2.2 55.9 mm	8.0 203.2 mm

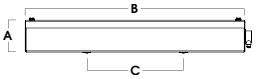
EMERGENCY BATTERY OPTIONS

EMRM* - 7W REMOTE EMERGENCY BATTERY (50' MAX)



A	B	C
1.3	12.6	13.0

EMEN* - 7W REMOTE EMERGENCY BATTERY WITH ENCLOSURE (50' MAX)



A	B	C
2.0	17.0	6.2

*OTHER EM BATTERY SIZES AVAILABLE, CONSULT FACTORY

ISSUED FOR PERMIT

B17 CHILD DAY-CARE CENTER

4" SQUARE DIRECT

PICO SERIES / PHOTOMETRIC DATA

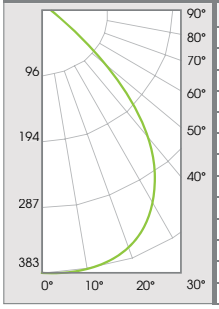
cylinders

20 MAY 2022

C0455SQXT-10LxxK-XWEX-SOxxMW

10L XTRA WIDE - 83 CRI

CANDLEPOWER CURVE



TEST: SP-00574_3

Angle	CP at 0°
0	381
5	383
10	378
15	371
20	361
25	345
30	321
40	211
50	77
60	29
70	13
80	5
90	2

ZONAL LUMENS

0-10	36	5%
0-20	141	20%
0-30	300	43%
0-40	480	68%
0-60	667	95%
0-80	699	100%
0-90	702	100%
Total Lumens	702	100%

SINGLE UNIT: PERFORMANCE
INITIAL FOOTCANDLES AND BEAM ANGLE DIAMETERS

Mounting Height*	FC at Center	Diameter of Beam**	FC at Beam**
5.5'	13	9.7'	4
6.5'	9	11.4'	3
7.5'	7	13.2'	2
8.5'	5	15.0'	1
10.0'	4	17.6'	1
12.0'	3	21.1'	1
14.0'	2	24.6'	1
16.0'	1	28.2'	0

* From aperture to horizontal surface below.
** At IESNA defined Beam Angle, to 50% Max. CP.

Delivered Lumens: 702
Luminaire Watts: 9.1
LER: 77

CP @ 0° (Nadir): 381
Beam Angle: 82.7°
CRI: 83

Spacing Ratio: 1.24
Output Multipliers: 7L x 0.75

ISSUED FOR PERMIT

B17 CHILD DAY-CARE CENTER

COLOR OPTIONS - POWDER COAT PAINT FINISHES

NOTE: NO PRINTED IMAGE CAN EQUAL THE EXACT COLOR OF FINISH ON METAL.
SEE INDIVIDUAL SPECIFICATION SHEETS OR CONSULT FACTORY FOR ADDITIONAL INFORMATION.

SPECTRUM POWDER COAT COLORS

STANDARD CORD / STEM / CANOPY FINISHES

FIXTURE COLOR	STANDARD CORD COLOR	STANDARD CANOPY / STEM COLOR
Matte White, Textured White	Matte White	Matte White
Gloss White	Matte White	Gloss White
Matte Black, Textured Black	Matte Black	Matte Black
All Others	Matte Black	Same Color as Fixture
Custom Color	Contact Factory	Contact Factory

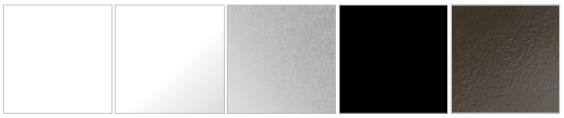
PAINT TIMES

TIER	COST	AVERAGE PAINT TIME*
Tier 1 - Standard Finishes	$	1
Tier 2 - Typical Finishes	$$	2
Custom Color	Contact Factory	Contact Factory

*CONTACT FACTORY FOR SPECIFIC PRODUCT LEAD TIMES

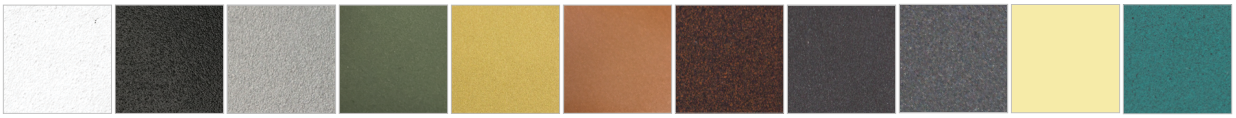
TIER 1 - STANDARD FINISHES

MW Matte White | **GW** Gloss White | **PT** Platinum Silver | **MB** Matte Black | **BZ** Bronze



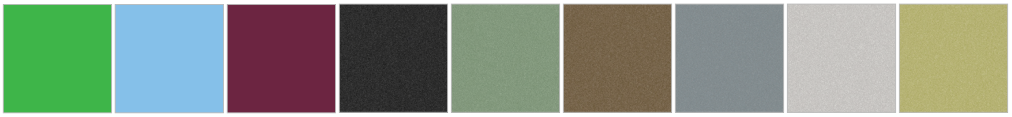
TIER 2 - TYPICAL FINISHES

TW Textured White | **TB** Textured Black | **MT*** Textured Silver | **OB*** Oil Rubbed Bronze | **SN** Sun Gold | **CO** Copper Metallic | **BR** Brecchia | **GH** Graphite | **CH** Charcoal | **AL** Almond | **VE** Verde Green



BL Blue Streak | **RD** Red Baron | **OR** Orange | **CM** Camel | **PL** Purple | **PG** Pub Green | **TQ** Turquoise | **SF** Sea Foam | **PK** Pink | **AY** Aero Yellow | **EG** Evergreen

LG Lime Green | **LB** Light Blue | **BY** Burgundy | **AK** Anodic Black | **AM** Anodic Malachite | **AZ** Anodic Bronze | **AS** Anodic Sapphire | **AN** Anodic Natural | **AC** Anodic Champagne



CUSTOM COLOR FINISHES

CONTACT FACTORY

CC Custom Color

*UNAVAILABLE FOR WET LOCATION

20 MAY 2022

ISSUED FOR PERMIT

B17 CHILD DAY-CARE CENTER

SPECTRUM LIGHTING INC.

83-90095_RA

Date: _____ Customer: _____

Project: _____

Type: _____ Qty: _____

selux

20 MAY 2022

ISSUED FOR PERMIT

B17 CHILD DAY-CARE CENTER

M60

LED Recessed
Wet Location

Order Code: _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____

Series

L60W Multi-Mount Form Wet Location	**L6WR1** Continuous Flange (Flanged Endcaps) Wet Location	**L6WR2** Continuous Flange (Flangeless Endcaps) Wet Location

Light Engine

1C45[1,2,3]	1C40[1,2,3]	1C35[1]	1C30[1,2]	1C25[1,2]	1C20[1,2]
80CRI-1018lm 90CRI-855lm 11.1W per foot	80CRI-954lm 90CRI-802lm 9.9W per foot	80CRI-834lm 90CRI-701lm 8.7W per foot	80CRI-746lm 90CRI-627lm 7.3W per foot	80CRI-594lm 90CRI-500lm 6.1W per foot	80CRI-494lm 90CRI-415lm 4.9W per foot

[1] Values calculated from a 4' fixture at 3500K, 90+ CRI using LW shielding and DIM driver. For additional information please see page 2.
[2] Available starting at 2' and up.
[3] Not available with Lutron.

CCT

927	930	935	940	827[4]	830[4]	835[4]	840[4]	RGBW
2700K 90+ CRI	3000K 90+ CRI	3500K 90+ CRI	4000K 90+ CRI	2700K 80+ CRI	3000K 80+ CRI	3500K 80+ CRI	4000K 80+ CRI	(consult factory)

[4] Consult factory for lead times

Shielding

LW[5]	MI[5]	NB	A2	A5	BW
LED Optimized White Lens	Clear Lens with Microprism	LMO Symmetric with Satine Lens	LMO Asymmetric 20° Wall Washer with Satine Lens	LMO Asymmetric 5° Wall Grazer with Satine Lens	LMO Batwing with Satine Lens

*See page 2 for details
[5] Impact resistant

Mounting L60W

SF1	SF2	SF3	DC
Spackle Flange (½" Drywall)	Spackle Flange (⅝" Drywall)	Spackle Flange (After Drywall)	Decoustic Ceiling (up to 2" thick)

or

Mounting L6WR1 or L6WR2

RC[6,7]	TS
Rotating Crossbar (Ceilings ¼" to 2" thick)	1" ¼"-20 Stud

[6] L6WR1 only
[7] Consult factory for lengths under 2'

Nominal Fixture Length

01*	02	03	04	05	06	07	08	XX
1 ft.	2 ft.	3 ft.	4 ft.	5 ft.	6 ft.	7 ft.	8 ft.	Runs (over 8') round up to the nearest foot and replace the "xx" with the # (i.e. 13=13' nominal)

*1' fixture only available with 1C35 light engine.
Individual fixtures and Runs are supplied in nominal lengths to ensure full, even, illumination. See pages 2 through 5 for additional details.

Finish

WH	BK	BL	SV	SP
White	Black	Semi-Matte Black	Silver	Specify Premium Color

* Custom colors are available, please consult factory

Voltage

1	2	U	3
120V	277V	120V through 277V 50/60Hz capable	347V (consult factory)

Driver

DIM[8]	DIL[8,9]	DED[8,9]	D01[8,9]	DL01[8,9]	DC2[8,9,10]	DE1[8,9]	DC3
0-10V 1% (Linear)	eldoLED 1% ECOdrive 0-10V (Logarithmic)	eldoLED 1% ECOdrive DALI (Logarithmic)	eldoLED 0.1% SOLOdrive 0-10V (Linear)	eldoLED 0.1% SOLOdrive 0-10V (Logarithmic)	Lutron 1% 2-Wire	Lutron 1% EcoSystem	Lutron 1% 3-Wire (consult factory)

[8] See page 6 for full details
[9] Not available for 1' length
[10] 120V only

Fixture Options

FS[11]	SS[11]	CCEA	TR[11]
In-line Fuse	Separate Switching	CCEA approved	Tamper Resistant ¼" End Cap

[11] See page 8 for details.

Emergency Options

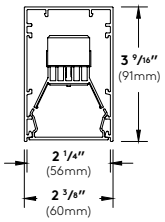
EC[12]	EMR	EM[12,13,14]
Emergency Circuit Wiring	Remote Micro Inverter (consult factory)	Integral EM battery pack (Non-IC rated)

[12] See page 8 for full details and restrictions
[13] Integral EM available in 4' and ≥6' lengths (except for DM, DML and DMD options in a 4' length). Please consult factory for 5' length.
[14] Minimum 32°F

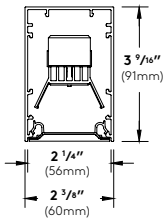
BUY AMERICAN · NRTL WET · 5 YEAR LED WARRANTY · ARRA Compliant · ADA Compliant · RoHS COMPLIANT · UNION MADE IBEW LOCAL 363 · LUTRON DIM ADVANTAGE

M60
LED Recessed Wet Location

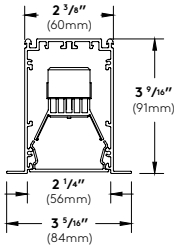
selux



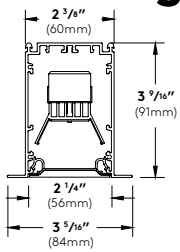
L60W Housing
Lens Depicted



L60W Housing
Snap-in Gasket Depicted



L6WR1/R2 Housing
Lens Depicted



L6WR1/R2 Housing
Snap-in Gasket Depicted

Construction:

Housing - Continuous, low copper 6063-T6 extruded aluminum profile with aluminum endcaps, available as Individual fixtures (up to 8') or Runs.

Flange - 9/16" (14mm) wide flange runs full lengths of both sides and is part of the main extruded body. Specify continuous flange (L6WR1) or flush (L6WR2) end cap. L6WR2 does not work in T-Bar ceiling.

Geartray - Low copper 6063-T6 extruded aluminum profile.

Shielding - Extruded, impact resistant acrylic lens.
- LED Optimized White Lens (LW)
- Clear Lens with Microprism (MI)

"LMO" refers to the Selux proprietary LED optical system - Light modulation optics. These lenses are offered in M60 Wet Location behind a Satine Lens for even illumination and comfortable lit appearance. The following lenses are not impact resistant:
- "LMO" Symmetric lens (NB)
- "LMO" Asymmetric 5° Wall Grazer (A5)
- "LMO" Asymmetric 20° Wall Washer (A2)
- "LMO" Batwing (BW)

* Please note that the snap-in cover is a frosted acrylic, designed to match the visual appearance of the LW Lens.

Gasketing - Frosted acrylic snap-in cover plate at ends and each joint, combined with transmissive gasket ensures ease of installation and a clean, illuminated surface.
*Housings other than White may have additional shadowing at the cover plates.

Tamper Resistant - Aluminum plates with gasket and tamper-resistant hardware replaces the snap-in cover at ends and joints. Painted housing color by default.

Mounting(s) - Spackle in (drywall), Slot Grid, Decoustic, T-bar Grid, Rotating Crossbar and Threaded Stud Mountings (RC or TS mountings). See pages 3 through 5 for details.

Standard Luminaire lengths - All standard luminaires are supplied in nominal lengths to ensure full, even, illumination.

Runs are available in approximately ¼" increments starting at the nominal 8' fixture length.
**Individual luminaires are not joinable in the field.

Exact Luminaire lengths - Individual luminaires and Runs are available in exact lengths to meet your project needs. Please consult factory with your requirements.
**Lens luminance may soften at the very ends of the straight sections for exact length luminaires.

L60W Joiner(s) - Runs are supplied in multiple housings that are joined together in the field using the supplied L60W Joiner System. This allows ease of installation and ensures a uniform appearance (see page 8 for detail).

Weight: 2.4 lb. per foot.

Electrical/Performance:

LED Light Engine - Brand-name mid-power LEDs create a high efficiency LED light engine able to provide a lumen maintenance of 95% at 25,000 hours and 90% at 60,000 hours at 25°C per TM-21 reports. Reported L70 greater than 60,000 hours.

Photometrics - Consult website or factory for IES Files. Independent photometric lumen measurement complies with IES LM-79-08 testing procedures. Due to the LED manufacturer's tolerances, the listed output has a ±5% tolerance. For outputs based on different optics or CCT, please see pages 9-11 for details.

CCT - Available in 2700K, 3000K, 3500K and 4000K, tolerance within a 3-step MacAdam ellipse.

CRI - 90+ and 80+ CRI. Consult factory for lead times of 80 CRI.

Emergency - There are multiple emergency options available - emergency circuit, remote micro inverter, and integral battery pack. All options compliant with UL 924 listed emergency luminaire. Please consult factory for use of sensors with emergency options. For more details on EC and EM options, see page 8.

All Drivers - High efficiency, constant current, soft start, Electronic Class 2 with a PFC>0.90. For more detailed information on the available drivers, please see page 6.

Thermal Performance:

Ambient Operating Temperature - Luminaires suitable for maximum ambient temperature of 35°C (95°F) for all drivers.

Luminaires are suitable for minimum ambient temperatures of -40°C (-40°F) for DIM, DIL, DED, D01, and DL01 drivers; 0°C (32°F) for DC2 and DE1 drivers.

Luminaire Finish:

Powder Coat - All Selux luminaries are finished in high quality polyester powder coating in our Tiger Drylac certified facility and are tested in accordance with test specifications for coatings from ASTM and PCI.

All products undergo a five stage intensive pretreatment process where product is thoroughly cleaned, phosphated, and sealed. Selux powder coated products provide excellent salt and humidity resistance as well as ultra violet resistance for color retention.

Standard interior colors are White (WH), Black (BK), Semi-Matte Black (BL), and Silver (SV). Selux premium colors (SP) are available, please specify from your Selux color selection guide. Housing colors other than White may have additional shadowing at the cover plates.

Warranty:

5 Year Limited LED Luminaire Warranty - Selux offers a 5 Year Limited Warranty to the original purchaser that the M60 series LED luminaire shall be free from defects in material and workmanship for up to five (5) years from date of shipment. This limited warranty covers the LED driver and LED light engine when installed according to Selux instructions and operated within the Ambient Temperature. For additional details and exclusions, see "Selux Terms and Condition of Sale."

Certifications and Compliance:

NRTL - For Dry, Damp, and Wet location
(I.E. cULus; cCSAus)
Suitable for ceiling installation only – space behind ceiling Dry or Damp Location.
Not suitable for floor, vertical or horizontal wall recessed installation.
ARRA Compliant
RoHS Compliant
IC Rated *
*EM option is non-IC Rated

0-10V linear dimming (DIM)
Luminaires supplied with drivers offering the capability of either normal switched operation of 0-10V dimming for linear dimming curve. Fixtures ship wired for dimming. For on/off functionality, simply cap the dimming leads. Minimum dimming level preset at factory to 1%. (Due to size constraints, 1' side length luminaires are supplied with a driver from a different manufacturer than 2' and above luminaires. For details, please consult factory).

0-10V logarithmic eldoLED ECOdrive dimming (DIL)
Luminaires supplied with drivers offering the capability of either normal switched operation of 0-10V dimming for logarithmic dimming curve, Fixtures shipped wired for dimming. For on/off functionality, simply cap the dimming leades. Minimum dimming level preset at factory to 1%.

eldoLED ECOdrive DALI dimming (DED)
Luminaires supplied with ECOdrive DALI dimming driver with logarithmic dimming curve. Minimum dimming level preset at factory to 1%. For "dim to dark" (down to 0.1%), please consult factory.

eldoLED SOLOdrive 0-10V linear dimming (D01)
Luminaires supplied with SOLOdrive 0-10V dimming driver with linear dimming curve. Minimum dimming level preset at factory to 0.1% and "dim to dark".

eldoLED SOLOdrive 0-10V logarithmic dimming (DL01)
Luminaires supplied with SOLOdrive 0-10V dimming driver with logarithmic dimming curve. Minimum dimming level preset at factory to 0.1% and "dim to dark".

LUTRON 2-wire dimming (DC2)
Luminaires supplied with Hi-Lume 2-wire dimming driver (120V only) programmed for Constant Current Reduction (CCR). For Pulse Width Modulation (PWM) dimming, please consult factory. Minimum dimming level down to 1%.

LUTRON EcoSystem dimming (DE1)
Luminaires supplied with Hi-Lume EcoSystem (4 wire, digital link) dimming driver programmed for Constant Current Reduction (CCR). Minimum dimming level down to 1% with SoftOn/FadeToBlack.

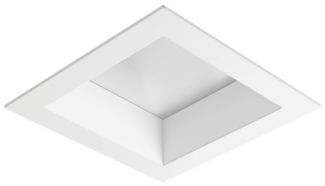
*For control recommendations, please contact driver manufacturer.

Driver Quantity													
Light Engine	**Dimming Code**	**Length**											
		1ft	**2ft**	**3ft**	**4ft**	**5ft**	**6ft**	**7ft**	**8ft**	**9ft**	**10ft**	**11ft**	**12ft**
1C20	DIM/DIL	N/A	1							2	2		1
	D01/DL01/DED												
	DE1												
	DC2									3	3		2
1C25	DIM/DIL		1					1		2	2		1
	D01/DL01/DED												
	DE1												
	DC2							2		3	3		2
1C30	DIM/DIL		1				1			2	2		2
	D01/DL01/DED												
	DE1												
	DC2						2			3	3		3
1C35	DIM/DIL	1	1				1	2	1	2	2		2
	D01/DL01/DED							1					
	DE1							2					
	DC2						2		2	3	3		3
1C40	DIM/DIL	N/A	1				1	2	2			3	
	D01/DL01/DED							1					
	DE1		N/A										
	DC2												
1C45	DIM/DIL		1			2	1	2		3	2	3	
	D01/DL01/DED					1							
	DE1		N/A										
	DC2												

TECH LIGHTING®

ELEMENT™ 4" PRO SERIES LED

FIXED DOWNLIGHT



SHOWN IN FLANGED SQUARE

The Element 4" Pro Series Fixed downlight introduces a budget-friendly, specification-grade downlight with wide-angle distribution for commercial applications. Engineered with a precision diffuser and Solite Soft Focus lens that eliminates hot spots, direct visibility into the housing, and delivers a clean aperture and ceiling aesthetic. The Element 4" Pro Series is offered in a variety of options, including multiple outputs, beam spreads and the choice of Static White, Warm Dim or Tunable White to meet any commercial requirements.

- Budget-friendly solution for commercial spaces
- High-Output and wide-angle beam spreads engineered for large spaces
- 1-step standard color binning
- High efficacy: >100 lumens per watt (reference specification chart for detail)
- Lutron/eldoLED options

LUMEN MULTIPLIER (CRI/CCT)

CCT	80 CRI MULTIPLIER	90 CRI MULTIPLIER
2700K	0.95	0.80
3000K	1.00	0.85
3500K	1.05	0.90

Lumen output will vary by CCT and CRI.
See photometric charts for output information.

SPECIFICATIONS

		STATIC WHITE		WARM DIM		TUNABLE WHITE	
HOUSING (RATING)	Wattage	Lumens	Efficacy	Lumens	Efficacy	Lumens	Efficacy
E4PH (IC/NIC/CP) E4PEMH (NIC/CP)	7W	750	104	612	77	516	65
	12W	1200	103	919	77	774	65
	15W	1500	100	1302	77	1097	65
E4PH (IC/NIC/CP) E4NGEMH (NIC/CP)	19W	1900	99	1839	77	1548	65
E4NGH (IC/NIC/CP) E4NGEMH (NIC/CP)	27W	2550	94	2375	77	2000	65
E4NGH (NIC/CP) E4NGEMH (NIC/CP)	36W	3200	90	NA		NA	
CRI		80+, 90+		90+		90+	
CCT		2700K, 3000K, 3500K, or 4000K		3000K - 1800K		5000K - 2700K	
COLOR CONSISTENCY		1-step		3-step		2-step	
VOLTAGE		120V or 277V					
DIMMING[1]		Standard reverse-phase, forward-phase, TRIAC, and 0-10V dimming (down to 1% or 5%+ depending on wattage) Lutron Hi-lume EcoSystem (down to 0.1%) | Lutron Hi-lume 2-wire (down to 1%) EldoLED 0-10V or Dali (down to 0.1%)				EldoLED 0-10V or Dali (down to 0.1%)	
POWER SUPPLY		Constant current driver with +.9 power factor and +80% efficiency					
BEAM SPREAD		65°, 75°, 85°, or 95° Note: Optics are not field changeable					
ADJUSTABILITY		N/A					
CEILING APPEARANCE		Flanged, Flangeless or Flangeless in Wood Ceiling					
CEILING THICKNESS		Flanged: Up to 2-1/2" | Flangeless: No ceiling thickness limitations | Flangeless in Wood Ceiling: No ceiling thickness limitations					
CEILING APERTURE		4-1/2" ceiling cutout					
HOUSING		IC Airtight, Non-IC Airtight, Chicago Plenum. IC suitable up to R60 spray foam insulation.					
CONSTRUCTION		Housing: Heavy-Gauge, Cold-Rolled Steel | Trims: Die-Cast Aluminum					
FINISH		Housing: Black Powder Coat | Trim: Select finish options for Bevel and Flange separately: White, Black, Haze Silver					
GENERAL LISTINGS		ETL Listed. Wet Listed.					
CALIFORNIA TITLE 24		Registered CEC Appliance Database. Can be used to comply with CEC 2019 Title 24 Part 6 (JA8-2016, JA8-2019) (for 90 CRI versions).					
L70		50,000 hours min					
WARRANTY[2]		5 years					

Data in chart reflects 3000K/80CRI values unless noted. Lumen values are delivered lumens, not source lumens.
Custom Output/Custom RAL/Custom CCT available, Contact Quotes Department
Ordering grids available on page 2.
[1]See ELEMENT-Lighting.com for dimmer compatibility.
[2]Visit ELEMENT-Lighting.com for specific warranty limitations and details.

UPDATED 3/4/22

TECH LIGHTING

ELEMENT™ 4" PRO SERIES LED

FIXED DOWNLIGHT

ORDERING GRIDS

HOUSING

PRODUCT	CEILING APPEARANCE	OUTPUT	FUNCTION	HOUSING RATING	DRIVER	VOLTAGE
E4PR ELEMENT 4" PRO SERIES ROUND **E4PS** ELEMENT 4" PRO SERIES SQUARE	**L** FLANGELESS **F** FLANGED **WC** WOOD CEILING[1]	**-L07** 7W (750 LMS)[2] **-L12** 12W (1200 LMS) **-L15** 15W (1500 LMS) **-L19** 19W (1900 LMS) **-L27** 27W (2550 LMS) **-L36** 36W (3200 LMS)[3]	**D** DOWNLIGHT GENERAL ILLUMINATION	**I** IC AIRTIGHT **N** NON-IC AIRTIGHT **C** CHICAGO PLENUM **E** EMERGENCY BATTERY BACK-UP (NON-IC AIRTIGHT/ CHICAGO PLENUM)[4]	**INTEGRATED DRIVERS 120V/277V** UNIVERSAL PHASE/0-10V 1% (LEAVE BLANK)[5] **-ELD0** ELDOLED 0.1% 0-10V LINEAR **-ELD0A** ELDOLED 0.1% 0-10V LOGARITHMIC **-ELDD** ELDOLED 0.1% DALI **-ELT0** ELDOLED TUNABLE WHITE 0.1% 0-10V LINEAR 2-WIRE[6] **-ELTD** ELDOLED TUNABLE WHITE 0.1% DALI[6] **-HLECO** LUTRON HI-LUME 0.1% ECOSYSTEM[7] **INTEGRATED DRIVERS 120V** **-HL2W** LUTRON HI-LUME 1% 2-WIRE	120 VOLT (LEAVE BLANK) **-2** 277 VOLT
		-	D			

See Driver and Wattage Housing Compatibility Chart below for information on IC and Non-IC options.
Trims are required and must be ordered separately.
Hanger bars not included with smaller E4PH and E4PEMH Housings. Order separately if required.
Output lists nominal wattage and lumens at 3000K/80CRI; actual wattage and lumens may vary slightly.
[1]WC - Wood Ceiling accommodates Flangeless trims only. For flanged trims in a wood ceiling use standard flanged housing.
[2]L07 - Dimming performance with standard UNIVERSAL PHASE/0-10V driver varies dramatically from <1% to >10% depending on the dimmer; please refer to Dimmer Compatibility chart.
[3]L36 - Output only available Non-IC/CP. Not available with WD31 Warm Dim or TW52 Tunable White. Not available with HL2W and HLECO drivers.
[4]E - Emergency Battery Back-up available in smaller E4PEMH Housing (above ceiling access required) only for L07, L12 and L15 output. Emergency battery back-up available in larger E4NGEMH Housing only for L19, L27 and L36 output. For use with DEM trims only.
[5]Universal dimming is reverse-phase, forward-phase, and TRIAC. The standard UNIVERSAL PHASE/0-10V driver dims to 1% with L12 and L15, and to 5% with L07, L19, L27 and L36. Dimming performance varies by dimmer; please refer to Dimmer Compatibility chart.
[6]ELT0/ELTD - Tunable White TW52 available with ELT0 (0-10V, linear) or ELTD (DALI) only. For 0-10V logarithmic dimming consult Quotes Department.
[7]HLECO - Lutron has put their entire 0.1% ECO drivers on indefinite hold which impacts all -HLECO item numbers. Please consult factory for alternatives. This does not impact -HL2W.

TRIM/LIGHT MODULE

PRODUCT	CEILING APPEARANCE	STYLE	FUNCTION	CRI/CCT	BEAM SPREAD	BEVEL FINISH	FLANGE FINISH
E4PR ELEMENT 4" PRO SERIES ROUND **E4PS** ELEMENT 4" PRO SERIES SQUARE	**L** FLANGELESS **F** FLANGED **F15** FLANGED 1.1"-1.5" CEILING THICKNESS **F20** FLANGED 1.6"-2.0" CEILING THICKNESS **F25** FLANGED 2.1"-2.5" CEILING THICKNESS	**R** REGRESS (1.0")	**D** DOWNLIGHT GENERAL ILLUMINATION **DEM** DOWNLIGHT GENERAL ILLUM. EM[1]	**-830** 80 CRI, 3000K, 1-STEP **-835** 80 CRI, 3500K, 1-STEP **-840** 80 CRI, 4000K, 1-STEP **-927** 90 CRI, 2700K, 1-STEP **-930** 90 CRI, 3000K, 1-STEP **-935** 90 CRI, 3500K, 1-STEP **-940** 90 CRI, 4000K, 1-STEP **-WD31** 90 CRI, 3000K-1800K, WARM DIM, 3-STEP[2] **-TW52** 90 CRI, 5000K-2700K, TUNABLE WHITE, 2-STEP[3]	**6** 65° DIFFUSER WITH SOLITE **7** 75° DIFFUSER WITH SOLITE **8** 85° DIFFUSER WITH SOLITE **9** 95°+ DIFFUSER WITH SOLITE	**-W** WHITE **-B** BLACK **-HS** HAZE SILVER	FLANGELESS ONLY (LEAVE BLANK) **W** WHITE **B** BLACK
		R		-			

[1]DEM - Downlight General Illumination EM Trim has test switch integrated into bevel portion of trim. For use with E4PEMH and E4NGEMH Housings only.
[2]WD31 - Warm Dim not available with HL2W for L07 and L36 output, and not available with HLECO for L07, L19, L27, and L36 output.
[3]TW52 - Tunable White for use with ELT0 (0-10V, linear) or ELTD (DALI) Housings only. For 0-10V logarithmic dimming or TW41 4000K-1800K consult Quotes Department. Not available for L36 output.

HANGER BARS

PRODUCT	STYLE
HNGBAR HANGER BAR SET	**-S** STANDARD **-P** PREMIUM[1]
HNGBAR	-

Order one set per fixture if required.
Hanger bars can be extended from 14" to 24" unless otherwise noted.
[1]P - Premium Hanger Bar Set has a standard extended length from 10"-24".
To extend to 36", order two sets per fixture and join together.
To extend to 48", order three sets per fixture and join together.

DRIVER AND WATTAGE HOUSING COMPATIBILITY CHART

ITEM NUMBER	DESCRIPTION	WATTAGE						
		E4PH HOUSING				E4NGH HOUSING		
		L07	L12	L15	L19	L19	L27	L36[2]
	STANDARD REVERSE-PHASE, FORWARD-PHASE, AND TRIAC 1% OR 5%+ DEPENDING ON WATTAGE[1]	IC	IC	IC	IC	-	IC	NON-IC
-010	0-10V DIMMING 1% OR 5%+ DEPENDING ON WATTAGE	IC	IC	IC	IC	-	IC	NON-IC
-ELD0	ELDOLED 0.1% 0-10V LINEAR	IC	IC	IC	IC	-	IC	NON-IC
-ELD0A	ELDOLED 0.1% 0-10V LOGARITHMIC	IC	IC	IC	IC	-	IC	NON-IC
-ELDD	ELDOLED 0.1% DALI	IC	IC	IC	IC	-	IC	NON-IC
-ELT0	ELDOLED TUNABLE WHITE 0.1% 0-10V LINEAR	IC	IC	IC	IC	-	IC	NON-IC
-ELTD	ELDOLED TUNABLE WHITE 0.1% DALI	IC	IC	IC	IC	-	IC	NON-IC
-HL2W	LUTRON HI-LUME 1% 2-WIRE	IC	IC	IC[1]	NON-IC	IC	NON-IC	-
-HLECO	LUTRON HI-LUME 0.1% ECOSYSTEM	IC	IC	IC	IC	-	IC	-

[1]No Branch Wiring.
[2]L36 Output only available Non-IC/CP in larger E4NGH Housing. Not available with WD31 Warm Dim or TW52 Tunable White.
Emergency Battery Back-up available in smaller E4PEMH Housing (above ceiling access required) only for L07, L12 and L15 output.
Emergency Battery Back-up available in larger E4NGEMH Housing only for L19, L27 and L36 output.

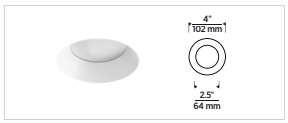
TECH LIGHTING

ELEMENT™ 4" PRO SERIES LED

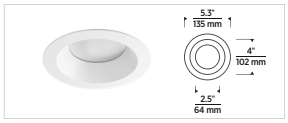
FIXED DOWNLIGHT

TRIMS

ROUND

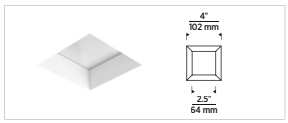


FLANGELESS



FLANGED

SQUARE



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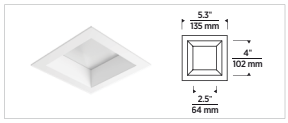


FLANGED

FINISH OPTIONS

NO FLANGE

HAZE SILVER BEVEL

BLACK BEVEL

WHITE BEVEL

WHITE FLANGE

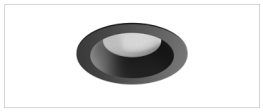
WHITE FLANGE, HAZE SILVER BEVEL

WHITE FLANGE, BLACK BEVEL

WHITE FLANGE, WHITE BEVEL

BLACK FLANGE

BLACK FLANGE, HAZE SILVER BEVEL



BLACK FLANGE, BLACK BEVEL

BLACK FLANGE, WHITE BEVEL

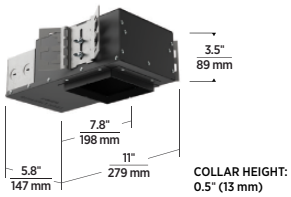
TECH LIGHTING

ELEMENT™ 4" PRO SERIES LED

FIXED DOWNLIGHT

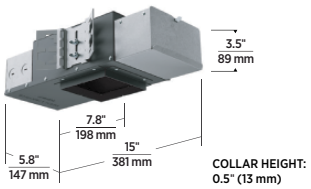
HOUSINGS

E4PH



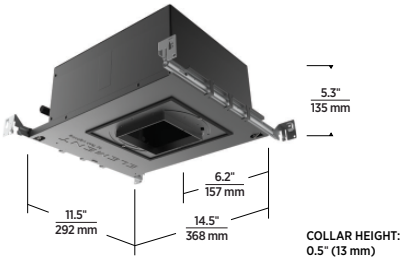
IC AIRTIGHT / NON-IC AIRTIGHT /
CHICAGO PLENUM (UP TO 19W)

E4PEMH



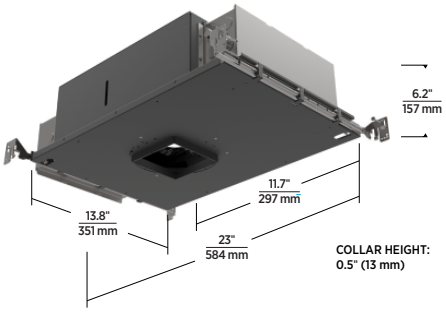
EMERGENCY BATTERY AIRTIGHT (NON-IC) /
CHICAGO PLENUM (UP TO 15W)
(ABOVE CEILING ACCESS REQUIRED)

E4NGH



IC AIRTIGHT / NON-IC AIRTIGHT /
CHICAGO PLENUM (27W AND ABOVE)
BELOW CEILING ACCESS PROVIDED

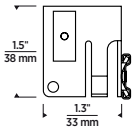
E4NGEMH



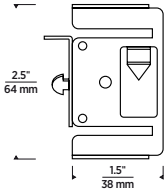
EMERGENCY BATTERY (NON-IC) AIRTIGHT /
CHICAGO PLENUM (19W AND ABOVE)
BELOW CEILING ACCESS PROVIDED

HANGER BARS

STANDARD

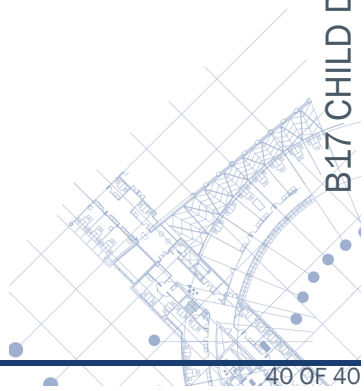


PREMIUM



END OF SECTION

26 50 10 APPENDIX A
SPECIALTY LIGHTING FIXTURE CUTSHEETS



SECTION 26 60 01 – FIRE PROTECTIVE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Central equipment (also referred to as head end equipment) including Fire Alarm Control Panel (FACP).

2. Graphic annunciator.

3. Outlying annunciator(s).

4. Analog-addressable smoke (and smoke-heat) sensor/detectors.

5. Analog-addressable smoke sensor/detectors with integral audible devices.

6. Addressable manual fire alarm stations.

7. Addressable heat detectors.

8. Sprinkler and fire standpipe alarm and supervisory devices furnished and installed separate from the work of this section.

9. Outlying addressable modules (monitoring or control) in addressable module boxes or cabinets.

10. Notification appliances.

11. Interfaces with pre-action sprinkler systems or other standalone sub-systems.

12. Addressable interface devices.

13. Digital alarm communicator transmitter.

14. Radio alarm transmitter.

15. System printer.

1.3 DEFINITIONS

A. FACP: Fire Alarm Control Panel.

B. LED: Light-emitting diode.

C. NICET: National Institute for Certification in Engineering Technologies.

D. Intelligibility: The quality or condition of being understood; comprehensible; clear.

E. STI: Sound Transmission Index

F. STIPA: Sound Transmission Index for Public Address

G. CIS: Common Intelligibility Scale

1.4 SYSTEM DESCRIPTION

A. Noncoded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.

B. Interconnection to campus-wide fire alarm system.

1.5 ACTION SUBMITTALS

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

B. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.

2. Include voltage drop calculations for notification appliance circuits.

3. Include battery-size calculations.

4. Include input/output matrix in accordance with the requirements of the local fire department.

5. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.

6. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

7. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.

8. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

9. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

10. Include list of materials and Underwriters Laboratories and Factory Mutual listing data.

11. Include drawings showing details of graphic annunciator.

12. Include drawings showing details of smoke control panel.

13. Include drawings showing details of post event smoke purge panel.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.

2. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire-alarm system design.

b. NICET-certified fire -alarm technician, Level IV minimum.

c. Licensed or certified by authorities having jurisdiction.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. A.Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," deliver copies to authorities having jurisdiction and include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.

3. Record copy of site-specific software.

4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

a. Frequency of testing of installed components.

b. Frequency of inspection of installed components.

c. Requirements and recommendations related to results of maintenance.

d. Manufacturer's user training manuals.

5. Manufacturer's required maintenance related to system warranty requirements.

6. Abbreviated operating instructions for mounting at fire-alarm control unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.

2. Program Software Backup: On magnetic media or compact disk, complete with data files.

3. Device address list.

4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.

2. Lamps for Strobe Units: Quantity equal to 10 percent of amount of each lamp type installed, but no fewer than 1 unit of each lamp type.

3. Smoke Detectors, Heat Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.

4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.

5. Keys and Tools: One extra set for access to locked and tamperproofed components.

6. Audible and Visual Notification Appliances: One of each type installed.

7. Fuses: Two of each type installed in the system.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm technicians and shall be supervised by personnel certified by NICET as fire-alarm Level IV technician.

C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL or an agency acceptable to the local jurisdiction.

F. Compliance with Local Requirements: Comply with the applicable building code, local ordinances, and regulations, and the requirements of the authorities having jurisdiction.

G. Comply with NFPA 70 as amended by state and local codes.

H. Comply with NFPA 72.

I. Comply with UL 864.

J. Comply with Americans with Disabilities Act (ADA), state and local disabilities access regulations.

K. Comply with NEMA Standards Publication SB 30 “Fire Service Annunciator and Interface”.

L. ANSI S3.2, Method for measuring the Intelligibility of Speech Over Communications Systems

M. IEC 60268-16, “Sound system equipment – Part 16: Objective rating of speech intelligibility by speech transmission index”.

N. ISO 7240-19, “Fire Detection and Alarm Systems – Part 19: Design, Installation, Commissioning and Service of Sound Systems for Emergency purposes”.

O. NEMA Standards Publication SB 50-2008 , “Emergency Communications Audio Intelligibility Applications Guide”.

P. Listing and Labeling: Provide fire alarm systems and components specified in this Section that are listed and labeled by Factory Mutual and Underwriters Laboratories.

Q. The system shall be complete with all components and wiring required for compliance with all applicable codes and regulations, and for its operation as described hereinafter. No exclusion from or limitation in the symbolism used on the drawings or the language used in these specifications shall be interpreted as a reason for omitting any appurtenances or accessories required to enable the system to perform the specified functions.

R. Upon completion of the installation (and as directed by the Architect), the work shall include making all arrangements and providing any assistance necessary for inspection and test as required for approval by the Fire Department. Modifications, adjustments, and/or corrective work necessary to obtain approval along with subsequent inspection and test resulting from the issuance of a "Notice of Defect" shall precede any consideration of formal acceptance by the Architect. In conjunction with the above, training as deemed necessary to instruct authorized building personnel in the proper operation of the system shall also form a part of the required work.

1.10 SEQUENCING AND SCHEDULING

A. Early completion of the Fire Protective Alarm system shall be required so as to permit a certificate of occupancy to be obtained in a timely manner, in accordance with a schedule established by the Architect.

1.11 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, the following:

1. Siemens Building Technologies, Inc.; Fire Safety Division.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. The system shall incorporate alarm (and other) operating features as follows:

INITIATION	RESULTING OPERATION
Operation of manual fire alarm stations	Sound alert tone signal through loudspeaker stations, and flash visual fire warning signals throughout building, followed by recorded announcements, followed by an evacuation tone signal. Sound audible signal and display "manual station" and zone identification at fire alarm control panel and outlying annunciators. Operate relay at fire alarm control panel to accommodate transmission of an “alarm” signal

INITIATION	RESULTING OPERATION
	to central station location.
Triggering of duct smoke detector	Initiate an automatic alarm zone verification sequence. Upon verification, sound audible signals and flash visual fire warning signals as noted for manual stations. Sound audible signal and display "duct smoke" detector and zone identification at fire alarm control panel and outlying annunciators. Operate relay at fire alarm control panel to accommodate transmission of an “alarm” signal to central station location. Operate outlying addressable modules to accommodate transmission of signals to dampers, fans, and/or other equipment as described hereinafter.
Triggering of area smoke or heat detector	Sound audible signal and display "area smoke" or "area heat" detector and zone identification at fire alarm control panel and outlying annunciators. Operate relay at fire alarm control panel to accommodate transmission of an “alarm” signal as specified above for manual stations. Operate outlying addressable modules to accommodate transmission of signals to dampers and fans.
Triggering of waterflow switch in sprinkler system.	Sound audible signal and display “waterflow” and zone identification at the fire alarm control panel and outlying annunciators. Sound audible signals and flash visual fire warning signals as noted for manual stations. Operate relay at fire alarm control panel to accommodate transmission of an “alarm” signal as specified above for manual stations. Operate outlying addressable modules to accommodate transmission of signals to dampers and fans.

INITIATION	RESULTING OPERATION
Operation of tamper switch on manual valve of sprinkler or fire standpipe system	Sound audible signal and display "manual valve tamper" and location identification at fire alarm control panel and outlying annunciators. Operate relay at fire alarm control panel to accommodate transmission of a "supervisory" signal to central station location.

2.3 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.

    a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.

    b. Include a real-time clock for time annotation of events on the event recorder and printer.

2. Addressable initiation devices that communicate device identity and status.

    a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.

    b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.

4. Control and monitoring of audible and visual alarm notification devices and associated circuitry shall be by means of addressable modules located in outlying system control cabinets.

5. The fire alarm control panel (i.e., the display and control section of the central equipment that requires operator interface) shall include all components necessary for the system to function as specified, and shall incorporate a custom built display panel arranged to match the main lobby decor as directed by the Architect. The display panel shall be arranged to enable a minimum of four simultaneous alarms to be displayed and shall include an overflow indicator and alarm advance feature. The display panel shall incorporate a back illuminated flashing fire sign module with 3 inch (7.6 cm) high red letters. Components of the central equipment that do not require operator interface shall be mounted in racks or cabinets. All required interconnections shall be included and shall be run in conduit.

6. Overall system supervision shall be accomplished by means of the response to continuous interrogating signals transmitted from the central equipment. The signal transmission rate shall be such that an "alarm" or "trouble" signal is processed and displayed within a 10 second maximum response time, and that subsequent initiation of automatic actions (fan shutdown, e.g.) shall be similarly initiated within 10 seconds.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 3 line(s) of 80 characters, minimum.

2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

3. LCDs and keyboards shall be "user friendly" incorporating the following features:

   a. English language display.

   b. Visually displayed prompts for access to "help screens," "system status files," etc.

4. System software shall be such that the use of the aforementioned special function keys shall enable commands to be carried out with minimum effort. For example, purging of the 4th floor shall be accomplished by typing "4" followed by depressing the "purge" key. This either initiates all required control functions or displays any further action required for the purge.

5. In lieu of the special function keys and associated software as described above, system software may be of a type that permits direct "English language" keyboard entries (without the need for look-up tables) as required for the manual control of fans and dampers for smoke control functions.

6. System display shall be prioritized so as to display alarms, controlled equipment status, supervisory indications and system test reports in a sequence and format as approved by the architect and by all authorities having jurisdiction. Specifically:

7. Equipment status display shall be derived from addressable monitoring modules controlled by limit switches or auxiliary contacts as indicated elsewhere.

8. Equipment status and/or changes in equipment status shall not be automatically displayed except that changes in status of equipment may be automatically displayed if they result from a fire alarm initiation event.

9. Where the status of equipment controlled by alarm initiation is not automatically displayed, the manual steps necessary to provide this display shall appear on the display screen along with the alarms.

10. Display formats that employ mnemonic codes and/or that depend upon written text material in order to properly operate the system shall not be considered as meeting these specifications.

11. The fire alarm control panel shall include a graphic annunciator panel in addition to the LCD specified hereinbefore. The panel shall display:

    a. Each fire reporting zone an LED (or other) status indication for each of the reporting device types (i.e., manual station, area smoke detector, duct smoke detector, heat detector, waterflow device, subsystem alarm).

    b. Each fan and the areas served by each, with a status LED for each.

C. The panel display shall comply in all respects with Fire/Building Department requirements regarding size, format, construction, and display.

D. Circuits:

1. Signaling Line Circuits

    a. Trunk Signaling Line Circuits: Circuits between the head-end equipment and outlying control cabinets. NFPA 72, Class X (formerly Class A, Style 7).

        1) The loop conductors shall be run in raceways (as specified hereinafter) throughout. The "sending" portion of the loops shall be physically separated from the "return" by a distance of not less than 15 feet (5 meters) except where they come together at the FACP.

        2) The trunk SLCs - in conjunction with their associated isolators and head end equipment - shall function so as to provide bi-directional signal transmission enabling receipt of alarms and signals at the FACP, and activation of addressable control modules from the FACP, in the event of a single open, a single ground, a wire-to-wire short or an open and a ground anywhere on the circuit. The only loss of transmission shall be for devices and/or modules connected to that portion of the loop (between isolators within the ECC) on which the wiring fault has occurred. Wiring faults on the loops shall result in trouble signals at the FACP that identifies the location of the faults.

    b. Branch Signaling Line Circuits: Circuits intended for the direct connection of outlying addressable initiating devices and/or modules. NFPA 72, Class A (formerly Class A, Style 6).

1) Include multiple "branch" SLCs within outlying system equipment control cabinets (ECCs) as required to ensure that no more than 50 alarm initiating devices and/or addressable monitoring modules associated with non-addressable alarm or supervisory initiating devices shall be connected to a single "branch" SLC. Each "branch" SLC shall be tapped from a "trunk" SLC by means of isolators that will disconnect it from the "trunk" SLC in the event of a wire-to-wire short (and will initiate a trouble signal identifying the fault at the FACP) so as to allow the remaining "branch" SLCs originating within the same ECC to function normally.

2) The loop conductors shall be run in raceways (as specified hereinafter) throughout, except that raceways may be omitted where conductors shall be concealed in the voids of removable hung ceilings, and at other locations (where not within 8 feet (2.4 meters) AFF) as specifically approved by the Engineer.

3) The "branch" SLCs shall function in conjunction with upstream circuitry and head-end equipment so as to provide bi-directional signal transmission enabling receipt of alarms and monitoring signals at the FACP, and activation of addressable control modules from the FACP, in the event of a single open, a single ground or an open and a ground on the circuit. Wiring faults on the circuits shall result in trouble signals at the FACP, identifying the faulted circuit.

2. Initiating Device Circuits: NFPA 72 Class A (formerly Class A, Style D).

a. Conductors for IDCs shall be installed in accordance with the requirements specified above for "branch" SLCs.

3. Notification Appliance Circuits: NFPA 72 Class B (formerly Class B, Style Y).

a. Conductors for IDCs shall be installed in accordance with the requirements specified above for "branch" SLCs.

4. Note that the use of "T-taps" or other such wiring techniques that limit the ability of addressable devices, addressable modules, notification appliances, or other devices to function normally in the event of wiring faults as described hereinbefore will not be allowed.

5. System equipment shall be of a type that ensures that all signal and communication circuits shall be of the "power limited fire protective limited fire protective signaling type" as defined in Article 760 of the National Electrical Code.

6. Serial Interfaces: RS-232 port for printer and for additional devices as required.

E. System supervision of outlying circuitry and equipment shall incorporate the following:

1. Supervision against circuitry wiring faults as described hereinbefore.

2. Supervision against unauthorized access and/or removal of components at ECCs as described hereinbefore.

3. Supervision of addressable alarm initiating devices, addressable control or monitoring modules, and other outlying devices against removal, or - as described hereinbefore - against malfunction.

4. Supervision of power supplies. Failure of any system power supply shall cause a trouble signal at the FACP identifying the affected power supply.

5. Supervision of smoke detector/sensor device sensitivity so as to provide a "dirty head" notification at the FACP identifying the affected device.

6. Supervision against loss of voltage at any system component requiring power for its proper operation. Such failure shall cause a trouble signal at the FACP identifying the location of the affected device(s).

7. Supervision against "off-normal" manually initiated actions at the FACP. Any such action shall cause an identifying trouble signal at the FACP.

F. Smoke-Alarm Verification for area type detectors:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.

2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.

3. Record events by the system printer.

4. Initiate alarm sequence if the alarm is verified.

5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

G. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

H. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

I. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, distributed amplifiers, and tone generators.

1. Amplifiers shall comply with UL 1711 and be listed by an NRTL.

a. Programmable tone and message sequence selection.

b. Standard digitally recorded messages for "Evacuation" and "All Clear."

c. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.

2. Status Annunciator: Indicate the status of voice/alarm speaker zone.

3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

J. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify device and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

K. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, and all system equipment shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

L. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed, valve-regulated, recombinant lead acid.

M. Instructions: Printed instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.

2. Station Reset: Key- or wrench-operated switch.

3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

B. Each station shall include an integral addressable monitor module (AMM) to permit a separately identifiable signal to be transmitted to the fire alarm control panel via signaling line circuits. The station's "electronics" shall be mounted behind the body of the station, accessible by authorized personnel only.

1. For manual stations located in unheated spaces provide the associated AMM located in a nearby heated space as indicated or as directed by the architect. Provide all required circuitry.

2.5 COMBINATION TYPE SYSTEM SMOKE AND CARBON MONOXIDE DETECTORS

A. Smoke detectors (also referred to as smoke sensors or sensor/detectors) shall be of the analog-addressable spot detector type. They shall be UL approved and installed in accordance with the manufacturer's recommendations as to spacing and suitability for use in the specific application with consideration for the number of air changes per hour, ceiling height, ceiling profile, normal space environment and the type of risk. Detectors, for ceiling mounting in finished spaces, shall be of the semi-flush type. It shall be understood that semi-flush mounting requires the device to be suitable for application to a concealed outlet box.

B. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.

2. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Base shall include integral addressable module arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

4. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.

5. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit. For combination heat / smoke detectors:

a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.

b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).

6. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.

7. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

a. Primary status.

b. Device type.

c. Present average value.

d. Present sensitivity selected.

e. Sensor range (normal, dirty, etc.).

C. Except as noted below, smoke detectors shall be of the photoelectric cell type with UL approved field adjustable sensitivity features.

D. Smoke detectors indicated in mechanical equipment rooms shall be of the combination photocell plus fixed temperature/rate-of-rise type.

E. Smoke detection devices that are mounted in ducts or in ceiling plenums shall be supplied with remote "triggered" indication pilot wired in parallel, in an approved manner, with the similar pilots included integrally with detection units. The pilots for duct detectors shall be each flush or surface mounted within 15 feet (4.5 meters) circuiting distance of its associated detector. Mounting and location shall be as directed by the Architect.

F. Smoke detectors indicated as being located in floor or ceiling cavities of the air handling type shall be equipped with "air shields" where air velocities are such as to require these appurtenances for the proper detection of smoke.

G. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.

2. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

3. Smoke detection devices that are mounted in ducts shall be supplied with remote "triggered" indication pilot wired in parallel, in an approved manner, with the similar pilots included integrally with detection units. The pilots for duct detectors shall be each flush or surface mounted within 15 feet (4.5 m) circuiting distance of its associated detector. Mounting and location shall be as directed by the Architect.

4. Duct smoke detectors shall be installed in accordance with the manufacturer's recommendations as to suitability for use in the specific application with consideration to air changes, size of duct, and location within duct, and shall include sampling chambers and pick up tubes where required. Where installed within ducts and/or above ceilings in air plenums, the provision of access doors and mounting holes in such ducts and plenums will be separate from this work. The installation of the tubes and sampling chambers, however, is part of the work of this section. In addition, responsibility for supplying detailed drawings showing exact dimensional locations of sampling tubes, etc., in the plenums and ducts, as required for the optimum operation will be part of this work. Where duct configuration is such as to interfere with laminar air flow, special provisions are included as follows:

   a. For unducted return systems, provide area type detectors, suitable for 500 feet per minute (150 meters per minute) air velocity, pipe mounted in the ceiling at the entry to the fan room. While every attempt has been made to properly define the required quantity of detectors (labeled "d"), at each such location, it is understood that detectors are provided on the following basis, regardless of the indicated quantities:

Duct Width	Quantity of Detectors
not more than 36 inches (91 cm)	1
greater than 36 inches (91 cm) but not more than 72 inches (182 cm)	2
greater than 72 inches (182 cm)	2 + (1) per each additional 24 inches (61 cm)

5. For each smoke detector mounted in a shaft, provide a fire rated access door of a type and finish approved by the architect.

2.6 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.

   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 135 deg F (57 deg C).

D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C). For use in boiler rooms, kitchens, and other rooms where a high ambient temperature is anticipated.

E. For detectors located in damp or wet environments provide devices labeled for use in such locations.

2.7 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, equipped for mounting as indicated, and with screw terminals for system connections.

1. Each enclosure assembly shall incorporate an integral visual warning signal (strobe) as described hereinafter.

2. Where indicated as being of the flush mounted type, they shall each consist of a round or square grille plate and flush mounting back box.

3. Where indicated as being of the surface mounted type, they shall each consist of an integral assembly of grille and enclosure, fully enclosing the appliance and associated electronics and/or matching transformer.

4. Where indicated as being of the bracket type, they shall each consist of an assembly of bracket mounting frame and audible appliance enclosure. Where two audible appliances are shown in a back to back configuration, or where the audible appliance is called-out as bi-directional, the two appliances shall be incorporated into a single assembly.

5. Mounting Faceplate: Factory finished red or white, as directed by Architect.

6. Mounting: Flush wall as standard, unless otherwise indicated on the drawings.

7. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

8. For appliances located in damp or wet environments provide devices labeled for use in such locations.

B. Voice/Tone Notification Appliances:

1. Appliances (loudspeakers) shall comply with UL 1480 and shall be listed and labeled by an NRTL.

2. Loudspeakers shall be approved for "Fire Alarm Service," with an audio power rating of at least 2 watts and a frequency response of 400 to 4,000 Hz. They shall have a typical sound pressure rating of at least 90 dBA at 10 feet (3 meters) when measured in an anechoic chamber. Where greater sound pressure levels are required to ensure audibility, speakers of higher wattage shall be provided. In particular, 15 watt speakers shall be utilized in mechanical rooms where the ambient sound level exceeds 70 db.

3. Loudspeakers shall comply with UL Standards applicable to loudspeakers for fire alarm use. The speaker shall be able to withstand 150 degrees F (55 degrees C) for three hours and still operate. The speaker shall be equipped with a multi-tapped matching transformer and a line supervision capacitor. The work of this section includes coordination of matching transformers and field settings of taps as required to provide code compliant audibility throughout. Each loudspeaker shall incorporate a visual warning signal (strobe) except as described.

4. Matching Transformers: Tap range matched to acoustical environment of speaker location.

5. Two or more loudspeaker circuits shall be provided to supply loudspeaker stations in evacuation signaling zone. Speakers shall be connected to these circuits so that adjacent speakers shall be connected to different circuits.

6. Voice communication in designated acoustically distinguishing spaces (ADS) shall be intelligible. Where speakers do not achieve the intelligibility requirements, locate and install additional speakers to achieve intelligibility for that notification zone. Refer to drawings for location of ADS.

C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens. Strobes shall be suitable for operation at a nominal voltage of 24 volts D.C. from power supplied by the system.

1. Rated Light Output: As indicated on drawings. Where not indicated, output shall be 15/30/75/110 cd, selectable in the field.

2. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.

3. Flashing shall be in a temporal pattern, synchronized with other units. Units shall be suitable for synchronized operation at a flash rate of 1 to 1.1 flashes per second, and shall be of the self-synchronizing type or shall be suitable for use with synchronizing control units integral with the power supplies, or interpolated in the circuitry between power supplies and strobes (visual notification appliances). Where not of the self-synchronized type, provide a sufficient quantity of synchronizing control units to fully utilize the installed power supply capacity for the project.

4. Strobes shall continue to flash until the system is reset.

5. Strobes shall be circuited as required, with no less than two circuits in evacuation signaling zone. Strobes shall be connected to these circuits so that adjacent strobes shall be connected to different circuits.

2.8 FIRE EVACUATION PUBLIC ADDRESS

A. The system shall provide for intercom and fire evacuation public address features as follows:

1. The system shall provide dual channel communications and distributed amplification. The system shall be capable of amplifier capacity and expansion as required. The system shall be of a dual channel type, capable of automatically broadcasting alert tones followed by recorded announcements repetitively to floor followed by evacuation tone.

2. Manual "on-off" control from the fire alarm control panel of evacuation tone signals, recorded announcements and flashing of strobes through loudspeaker stations on any or all floors. Manual deactivation of the loudspeaker evacuation tone from the fire alarm control panel shall deactivate flashing strobes.

B. The fire evacuation public address equipment in the system shall include the following features and functions:

1. Amplifiers shall be sized to accommodate a quantity of speakers equal to that shown on the drawings, plus an additional bulk quantity of 2 speakers intended for installation at locations as directed throughout the system. Sizing shall be based on an average requirement of 2.0 watts per speaker.

2. Amplifiers shall have a frequency response range of 1.5 dB from 30 to 10,000 hertz and at rated output, less than 2 percent distortion over the frequency range of 60 to 15,000 hertz.

3. Failure of a power amplifier shall shut down the amplifier and indicate a trouble condition. Amplifiers shall be arranged in such manner, either by pairing or automatic switchover, to provide redundancy.

4. Tone oscillators, microphone circuits, and ancillary equipment shall be paired in a similar fashion to the amplifiers and be provided with either automatic or manual switchover to the redundant system.

5. Where the audio path consists of twisted pair "riser cables," it shall include double the number of required pairs (as determined by the total number of speakers called for). Connections at the amplifiers shall be arranged to readily allow their "transfer" to future amplifiers as necessary.

2.9 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.10 OUTLYING ADDRESSABLE MODULES

A. Addressable Interface Device

1. Description: Microelectronic monitor module, UL listed for use in providing a system address for alarm initiating devices for wired applications with normally open contacts.

B. Outlying addressable module boxes (or cabinets) shall be distributed throughout the project and contain addressable monitoring and/or control modules as follows:

1. An addressable monitoring module ("initiating device" type, i.e., AMM/ID) shall be provided adjacent to each sprinkler or standpipe waterflow device and each non-addressable alarm or supervisory initiating device.

2. An addressable control module (ACM) shall be provided adjacent to each fan motor controller (or other device controller) for equipment whose operation must be automatically and/or manually controlled by the fire alarm system. Where two items are to be controlled at the same location, two such ACM units shall be provided.

3. An addressable monitoring module ("status" type, i.e., AMM/S) shall be provided adjacent to each fan motor controller (or other device controller) and adjacent to each fan motor in-sight disconnect switch (where provided) for equipment whose operational status must be monitored by the Fire Alarm System.

4. Auxiliary relays shall be provided to comply with requirements specified hereinafter.

2.11 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Include system functions and operating features as described below, plus those additional functions and features required by the authorities having jurisdiction. System design shall be such that neither the failure of the normal power source, the transfer to an emergency source, nor the retransfer to the normal source causes a change in system status (i.e., initiation of alarm signals or operation of equipment control relays).

B. The central equipment of the system shall incorporate redundant components so that the failure of any component does not interfere with system operation as described hereinafter. Submission of the system for approval shall include a detailed description of how compliance with this requirement is accomplished.

C. System supervision shall be such that the ability of all addressable alarm initiating devices and addressable modules to communicate with the central equipment is constantly monitored, and such failure results in an audible signal at the Fire Alarm Control Panel (FACP) and outlying annunciator(s) and a visual annunciation identifying the faulted device or module.

D. The system shall utilize a liquid crystal display (LCD) or electro-luminescent display capable of displaying at least 20 lines, with 80 characters per line for the display of all required alarm and equipment status information, and an associated keyboard to permit manual access to the system. For fire department use, selector switch and pilot light modules shall be also included at the Fire alarm control panel for status and manual access to fans and dampers. System response time shall be such that alarm indications shall be displayed within 10 seconds of occurrence. No portion of the "executive" program shall be stored on magnetic media. It shall be entered into the system by means of "firmware."

E. Smoke detection devices (variously identified herein as "smoke detectors", "smoke sensors" and "smoke sensor/detectors") shall be understood to be of the analog addressable smoke sensor type, for which the decision to initiate an alarm in response to the presence of smoke shall be software-driven from the fire alarm system central equipment. Provisions shall be incorporated at the central equipment to manually test and/or adjust the sensitivity of each smoke detector individually by means of a keyboard or keypad without requiring any replacement of equipment and/or "burning in" of firmware, and to print out a record thereof. The system shall also incorporate "alarm verification" features enabling a time-delayed re-check of any smoke detection signal prior to acknowledging a smoke alarm condition and acting thereon.

F. Power supplies serving visual warning signals shall be of the regulated type having an output of 28 VDC (adjustable to 30 VDC) plus or minus 3 percent.

G. Reset of all alarm initiating device circuits, alarm notification circuits, and equipment control relays shall be accomplished from the fire alarm control panel. Manual fire alarm stations shall require local reset before central reset from the fire alarm control panel is possible. In no case will the above alarm reset procedure cause the re-setting of equipment control relays. Such devices shall require separate reset from the fire alarm control panel.

H. It shall be possible to disconnect any floor, or any device or combination of devices on any floor, from the system to allow for maintenance, repairs, or the addition of system devices and wiring without disabling any other floor. Such disconnection shall cause a visual "disabled" annunciation at the fire alarm control panel identifying the floor and/or devices.

I. Each manual station, smoke or heat detector, sprinkler/standpipe alarm or supervisory actuating device, and sub-system alarm or supervisory initiating device shall constitute a separate zone for reporting to the fire alarm control panel. For display at the Fire Alarm Control Panel (FACP) and at outlying annunciator(s), each reporting zone (i.e., device) shall be individually identified, except that multiple smoke detectors (or multiple heat detectors) located within a single space may be identified by a common display. It shall be possible to separately identify and display the address of the individual detector(s) in alarm within any such space by means of an appropriate command at the FACP keyboard or keypad.

J. The system shall include the following features associated with the analog addressable smoke detectors (sensors):

1. An independent "alarm verification" feature for each individual smoke detector. In response to activation of a detector, the system shall not go into alarm until the detector has been reset, and has gone into alarm once again. A suitable, adjustable, time delay shall be incorporated into the reset procedure. Provisions shall be incorporated to bypass this alarm verification feature for any or all detectors so as to comply with Fire Department requirements.

2. An independent "maintenance alert" feature for each individual detector, providing a notification at the FACP identifying any detector that is operating at or above a pre-determined adjustable percentage of its alarm threshold.

3. An independent "sensitivity adjustment" feature for each individual detector, allowing the adjustment to be made from the FACP.

4. An independent "test" feature for each individual detector, allowing detector operation to be checked from - and its sensitivity reported at - the FACP.

5. A "status report" feature that provides status reports and detector sensitivity reports for each individual detector. Status reports shall include a summary of any initiating devices (smoke detectors or other) that have been manually disabled by operator action. Such reports shall be printed out in response to a command from the FACP.

K. The central equipment shall be supplied with an emergency power unit including batteries and battery charging equipment that shall maintain this cabinet and all outlying equipment that it subfeeds operational without any change in status for a minimum period of twenty-four (24) hours. The emergency power unit shall be sized to meet the following minimum requirements: operating in normal (supervisory) mode, twenty-four (24) hours, followed by 4 hours of emergency operation, except that voice alarm signaling need operate for only fifteen minutes at maximum connected load. Increase if necessary to conform to additional requirements imposed by code enforcement agency. Optionally, emergency power to supply outlying equipment may be provided by local battery and charger units contained within the equipment. Battery low voltage alarm contacts shall activate "trouble" indication at the central equipment. Batteries shall be of the sealed maintenance free type.

L. The central equipment and outlying equipment cabinets shall incorporate power supply provisions capable of accommodating strobes (either individually mounted or incorporated integrally with audible notification appliances). Emergency power for the strobes shall be provided by means of batteries and chargers and sized for 5 minutes of continuous operation after 24 hours of supervision. Batteries shall be of the sealed maintenance free type.

M. The system shall include a station for manually activating the relay (called for elsewhere) at the central equipment intended for transmission of an alarm signal to "central station" via telephone wires. This station shall be located at the telephone switchboard (or at a location as specifically directed in the field) and includes all required circuitry.

N. Central equipment, signal transmission facilities, and outlying control cabinets shall have capacity to handle spare points (that are in addition to those required for all functions hereinbefore specified and/or indicated in the drawings) in accordance with the following criteria:

O. The system shall incorporate a "fail safe" control feature accounting for a lack of response to a fire alarm indication at the fire alarm control panel. The feature shall incorporate an "acknowledge" button on the fire alarm control panel, that if not depressed (following the appearance of a fire alarm indication) within a preset time period as stipulated by the Fire Department, will cause the evacuation tone signal to be sounded through all loudspeaker stations on the system.

P. Physical features of the Fire Alarm System shall comply with the following:

1. Components indicated on the drawings shall be located where shown. Components that are required for proper operation, but that are not indicated on the drawings shall be located in fire alarm equipment closets, mechanical or electrical rooms, at accessible locations within suspended ceilings, or at locations for which express permission of the Architect has been obtained.

2. The visual aspect of all components of the system that are exposed to view shall be acceptable to the Architect.

3. Consoles shall be for desk or wall mounting or for setting into an architectural wall, cabinet or table as directed by the Architect.

Q. Unauthorized access to operable components at the Fire alarm control panel shall be prevented by means of lockable hinged doors on panels.

R. Operating instructions shall be provided within the FACP or mounted beyond glass in a frame adjacent thereto.

S. For the Central Station Service, provide a 3/4 inch (DN 21) empty rigid conduit from the Fire alarm control panel to the telephone frame room. Also provide a 2 #12 THWN in 3/4 inch (DN 21) conduit run from a 20 amp fuse cutout in the Fire Signaling System cutout panel to the telephone frame room. Terminate both runs as directed.

2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.

2. Programming device.

3. LED display.

4. Manual test report function and manual transmission clear indication.

5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.

2. Address or Zone of the supervisory signal.

3. Address or Zone of the trouble-initiating device.

4. Loss of ac supply or loss of power.

5. Low battery.

6. Abnormal test signal.

7. Communication bus failure.

E. Secondary Power: from fire alarm system.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.13 RADIO ALARM TRANSMITTER

A. Transmitter shall comply with NFPA 1221 and shall be listed and labeled by an NRTL.

B. Comply with 47 CFR 90.

C. Description: Manufacturer's standard commercial product; factory assembled, wired, tested, and ready for installation and operation.

1. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.

2. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by Owner.

3. Normal Power Input: 120-V ac.

4. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.

5. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph (160 km/h) <Insert wind speed> with a gust factor of 1.3 without failure.

6. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.

7. Antenna-Cable Connectors: Weatherproof.

8. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.

D. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:

1. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.

2. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.

3. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.

4. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.

5. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.

6. Local Fire-Alarm-System Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm.

2.14 SYSTEM PRINTER

A. Printer shall be listed and labeled by an NRTL as an integral part of fire-alarm system.

B. The printer shall be located at the Fire alarm control panel or at another location as directed by the Architect.

C. The printer shall incorporate the following features:

1. It shall duplicate all alarm supervisory and trouble signals automatically generated by the system or operator action.

2. Changes in the status of fans, dampers, and other equipment shall not be printed unless the change was automatically generated by an alarm initiation.

3. Print format shall be of alpha-numeric character that includes the month, day, year, and time of occurrence, and the type and location of alarm, supervisory, and trouble conditions that exist. Alarm, supervisory, and trouble data shall be portrayed in English or mnemonic code that shall be readily identifiable (as approved by the Architect).

4. It shall print out status and sensitivity reports for the analogue addressable smoke sensors automatically generated by the system or by the operator. It shall also print out on command a listing of any indicating devices that have been "disabled" by the system operator.

5. It shall include a carriage that accepts standard (6 inch (150 mm) minimum width) roll or fan fold paper with tractor feed.

6. It shall operate at a print speed of a minimum of 30 characters per second and have a print density of 10 characters per inch (4 characters per cm).

D. The printer shall be supplied with paper feed features (bails, baskets, and the like) and a suitable printer stand.

2.15 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Listed for use with the device or appliance they protect.

2. Factory fabricated and furnished by manufacturer of device.

3. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 GENERAL

A. Submit separate unit price for each of the items listed below. Each unit price quotation shall be for complete work, furnished, installed, complete with pro-rata interconnecting circuitry as required for its proper operation. Equipment, materials, and installation methods shall be same as for base bid. Quotations shall be suitable for both additions and deductions. Unit price quotations are required for:

1. Audible notification appliance (with integral strobe unit).

2. Manual fire alarm station.

3. Smoke detector for flush or surface mounting.

4. Smoke detector (with sampling tubes) for duct mounting.

5. Individually mounted strobe unit.

B. Include as part of the base bid quotation the cleaning and sensitivity adjustment of smoke detectors and sampling tubes as needed during the warrantee period and the periodic regular testing of system devices to comply with Building Department and Fire Department requirements, during the warrantee period.

C. In addition to the base bid price quotation, submit separate quotations for each of the "Service Contract" components described hereinafter. It shall be understood that these quotations are for a one (1) year period commencing with the expiration of the warrantee period. The "contract" shall be renewable, at the Owner's option, for one (1) year periods up to a total of five (5) years. The renewal contracts shall be based on the original, escalated by the national CPI. The quotations shall be for the following:

1. Inspection and Test: Provide all material and labor to test system by actuating all outlying alarm initiating devices, all manual control devices at the fire control panel and annunciators, as well as verifying operation of all notification appliances. Adjust as required to provide optimum system performance. Cleaning and adjusting of smoke detectors is excluded. Parts and labor for repairs and/or replacements is also excluded. Provide unit prices for all components of the system, installed in place. This service shall be provided at regular intervals complying with the requirements of the Building Department and the Fire Department.

2. Cleaning and Adjusting Smoke Detectors: Provide all material and labor for cleaning and adjusting the sensitivity of all area and duct type smoke detectors and sampling tubes. Cleaning shall be performed every six months. The sensitivity shall be checked once per year, and adjusted as required to ensure compliance with UL requirements. Where detectors cannot be adjusted to so comply, they shall be replaced. Quotations shall be on a per unit basis for the cleaning and adjusting, with a separate quotation for replacement of any head that cannot be field adjusted to be within UL specified limits.

3. Repairs and Replacement: Provide all labor and parts as necessary to repair and/or replace any and all defective equipment components.

D. If the fire alarm system is not manufactured locally, but is supplied by a local distributor, the manufacturer will provide a "letter of support" stipulating that when - in the opinion of the engineer - the distributors efforts require backup, the manufacturer will provide at no cost to the Owner, all required technical support manpower in a timely manner during the installation period, and for a one year two year warrantee period thereafter.

E. The fire alarm system manufacturer shall stipulate to the following:

1. Upon acceptance of the system, the manufacturer, or his factory authorized distributor will turn over to the Owner the job-specific program information (on disk) to enable the servicing, repair, and expansion of the system by any factory-approved service agency the Owner opts to utilize.

2. Prior to award of contract, the manufacturer will furnish the names of three factory approved service agencies located within 50 miles (80 kilometers) of the project. Such agencies shall be capable of providing all levels of maintenance servicing and programming as may be required. Failure to comply will be sufficient grounds for disqualifying the system manufacturer.

3.2 INSTALLATION, GENERAL

A. Install system according to NFPA standards referred to in Parts 1 and 2 of this Section.

B. Each outlying component requiring a power supply for its proper operation shall receive this supply over wires extended from the central equipment in a code approved manner.

C. Comply with the applicable requirements of other sections of Division 16 for locating and routing circuitry, for installing circuitry, for firestopping and for identification.

D. Adjust the sensitivity of all smoke detector (sensors) on the basis of the actual environment to that each will be subjected (i.e., air movement, ambient dust/dirt levels and temperature, humidity levels) in accordance with manufacturer's instructions.

E. Paint the outside parts of all equipment cabinets and all junction boxes, pull boxes, and outlet boxes red.

3.3 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Install equipment with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

C. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.

2. Connect new equipment to existing monitoring equipment at the supervising station.

3. Expand, modify, and supplement existing control and monitoring equipment as necessary to extend existing control and monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

D. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.

2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.

3. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to NFPA 72 including Appendix A and Appendix B.

4. HVAC: Locate detectors not closer than 5 feet (1.5 m) from air-supply diffuser or return-air opening.

5. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.

E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

G. Audible Alarm-Indicating Devices: Install such that the top is not less than 90 inches (2.29m) above finished floor and not less than 6 inches (.15 m) below the ceiling. Install and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

H. Visible Alarm-Indicating Devices and Combination Audible and Visible Alarm Indicating Devices: Install such that the entire lens is not less than 80 inches (2.03 m) and not greater than 96 inches (2.40 m) above the finished floor, and not less than 6 inches (.15 m) below the ceiling. Install on flush-mounted back boxes. Provide box extension and furnish collar where wall depth cannot accommodate flush backbox.

I. Device Location-Indicating Lights: Locate in public space near the device they monitor.

J. Manual Pull Stations: Mount semiflush in recessed back boxes with top of operating handles 48 inches (1.22 m) above the finished floor.

K. Water-Flow Detectors and Valve Supervisory Switches: Connect for each sprinkler valve station required to be supervised. . Refer to fire protection drawings for quantities of detectors and switches.

L. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches (1.83 m) above the finished floor.

M. Annunciator: Install with top of panel not more than 72 inches (1.83 m) above the finished floor.

N. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that will resist the required wind load with a gust factor of 1.3 without damage.

3.4 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceway in accordance with the following. Conceal raceway except in unfinished spaces and as indicated. Note that certain circuitry has been specified hereinbefore as 2-hour rated. These requirements are in addition to the requirements that follow.

1. Cables shall be run in conduit except that conduit for other than" trunk" signaling line circuits and final connections to controlled equipment may be omitted where circuitry is run concealed in the voids of readily removable hung ceilings or at other locations where specific approval in writing has been granted by the Engineer. Note that control circuitry, regardless of voltage, for smoke control fans shall be run in conduit as required by the building code. Raceway shall be electric metallic or threaded conduit subject to the restrictions specified elsewhere for light and power circuitry. Where cables are run without conduit, cable insulation shall be of a fire-resistant low-smoke producing type, U.L. classified as power limited fire signaling circuit plenum cable (Type FPLP) in accordance with requirements of Article 760 of the National Electrical Code. This classification shall be clearly marked on the outer surface of the cable at regular intervals.

2. Cable shall be run in conduit throughout, and shall conform to the requirements for non-power limited fire protective signaling circuit cable as expressed in Article 760 of the National Electrical Code, and shall be U.L. classified to conform to these requirements. For conductors #14 AWG and larger, cable insulation types THHN, THHW, or XHHW is considered as fulfilling these requirements. Smaller size conductors shall have insulation types specifically U.L. approved as type NPLF, and so identified by markings on the outer surface of the cable at regular intervals. Conduit shall be electric metallic tubing or threaded metallic conduit subject to the restrictions specified for light and power circuitry throughout the project.

B. Minimum conductor size for circuitry supplying audible or visual notification appliances shall be #16 AWG copper and for all other circuitry not specifically sized elsewhere minimum conductor size shall be #18 AWG copper.

C. Wiring within Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Conduits shall not be permitted to enter the top of control cabinets. Only side and bottom entries shall be permitted.

E. Cable Taps: Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm circuit wiring and a different color code for supervisory circuits. Color-code audible alarm-notification circuits differently from alarm-initiating circuits. Use different colors for visual alarm-notification circuits. Paint fire alarm system junction boxes and covers red.

G. Where wires and cables are permitted to be run without conduit, they shall be independently supported from the building structure or ceiling suspension system at intervals not exceeding four feet on center, utilizing cable supports specifically approved for the purpose. Wires and cables shall not rest on or depend on support from suspended ceiling media (tiles, lath, plaster, as well as splines, runners, or bars in the plane of the ceiling), nor shall they be supported from pipes, ducts, or conduits. Where cables are bundled together, separate bundles shall be provided separately for each type of cabling and separately for each independent system. Bundling and/or supporting ties shall be of a type suitable for use in a ceiling air handling plenum regardless of whether or not installed in a plenum.

3.5 CONNECTIONS

A. Make addressable connections with a supervised interface device to the required devices and systems. Install the interface device less than 3 feet (1 m) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

B. Provide final connections (i.e., control circuit extensions) from each addressable module box to the equipment "controller" it services, utilizing THWN wires run in conduit in accordance with the following:

1. From each box supplying a fan motor, provide a 5 #14 control circuit run in conduit to the motor controller and connect as indicated on the drawings.

2. From each box supplying a smoke damper system, provide a 5 #14 circuitry run in conduit to damper control device and damper end switches. Provide for each a 120 volt supply from an emergency panel. Connect as indicated on the drawings. Provide a 2 #14 in conduit circuitry run to an interface control device (relay or other) for each damper that also requires operation by the automatic temperature control system. Device will be provided within 10 feet (3 m) of the damper as part of the automatic temperature control work. Connect as directed.

3. From each box supplying a lighting dimming system, provide a 4 #14 run in conduit to the controller and connect for over-ride to full brightness and status indication in response to operation of any manual station, waterflow switch or smoke detector on the system. Connect as directed.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.7 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.8 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by Commissioning agent Architect authorities having jurisdiction.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

2. Engage the services of an independent testing agency approved by the authority having jurisdiction where required by the authority.

C. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.

b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

4. Test audible appliances for the private operating mode according to manufacturer's written instructions.

5. Test visible appliances for the public operating mode according to manufacturer's written instructions.

6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

D. Voice communication shall be verified for intelligibility by using prerecorded messages or manual live voice announcements. Testing shall be performed by a fire alarm system factory trained personnel, or by a registered design professional. Quantitative measurements shall be permitted.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 26 60 01

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SECTION 26 60 08 - FIRE FIGHTER'S AUXILIARY BI-DIRECTIONAL RADIO COMMUNICATION SYSTEM (ARCS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes a fire fighter's communication bi-directional radio amplifier (RF signal booster) system.

B. Related Requirements:

1. Division 26 Section "Common Work Results for Electrical".

1.3 DEFINITIONS

A. ARCS: In - Building Auxiliary Radio Communications System also known as Fire Fighter's Communication Bi-Directional Radio System.

B. BDA: Bi-Directional Amplifiers also known as Emergency Radio Communication System (ERCES).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each component of the system.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting and attachment details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection, battery calculations.

3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

C. Sample Warranty: For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For system to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer. Installing contractor shall have at least 5 years of experience in the installation of radio communication systems. Provide services of an FCC radio telephone licensed technician to supervise installation, adjustments and tests of system.

B. Testing Agency Qualifications: Qualified according to fire department.

C. Testing Agency Qualifications: Member company of NETA or an NRTL.

D. Testing Agency Qualifications: FCC License.

E. Single-Source Responsibility: Obtain system components from a single source who assumes responsibility for compatibility of system components.

F. Compliance with Local Requirements: Comply with the applicable building code, local ordinances, and regulations, and the requirements of the authorities having jurisdiction.

G. Comply with NFPA 70 as amended by state and local codes.

H. Comply with NFPA 72 as amended by state and local codes.

I. Comply with NFPA 1221.

J. Comply with UL 2524

K. Comply with FCC regulations.

L. Comply with manufacturer’s recommendations for antenna warning signage.

M. Listing and Labeling: Provide systems and equipment specified in this Section that are listed and labeled Underwriters Laboratories.

N. TIA/TSB – 88C; Wireless Communications Systems – Performance in Noise and Interference – limited Situations.

O. New York State Fire Code

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of system that fail(s) in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Siemens (Basis of Design).

2. TowerIQ Inc.

3. Xtech Systems, Inc.

4. RF Solutions LLC

2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. The fire fighter's communication bi-directional radio amplifier (RF signal booster) system shall provide effective Fire Department radio communications throughout the building.

2.3 PERFORMANCE REQUIREMENTS

A. The signal booster shall be tuned to pass frequencies as directed by the Fire Department on the downlink and on the uplink. The tuned bandpass window shall pass the Fire Department primary channels.

B. The bi-directional gain shall be of a level to produce minimum signal levels as determined by the Fire Department over 95 percent of the area of each floor of the building utilizing the hand held radio units of the type(s) that are in use by the local fire department. Provide higher signal levels where required by the Fire Department.

C. Critical Areas. Critical areas, such as the fire/emergency command center(s), the fire pump room(s), standpipe cabinets, sprinkler sectional valve locations, and other areas deemed critical by the authority having jurisdiction at the time of plan examination, shall be provided with 100 percent floor area radio coverage.

D. The system shall receive and transmit broadcasts on frequencies as required to be compatible with local fire department equipment.

E. System design shall be such that neither the failure of the normal power source, the transfer to an emergency source, nor the retransfer to the normal source shall cause an interruption in system operation.

F. System supervision shall be such that the operation of all outlying equipment with active electronics is constantly monitored, and such failure shall result in an audible signal at the central equipment with a contact closure for connection to an alarm input point on the fire alarm system.

G. Provide supervised monitoring panel to annunciate status of the systems. The monitoring panel shall provide visual and labeled indication for:

1. Normal AC power
2. Loss of normal power
3. Signal booster trouble
4. Antenna failure
5. Battery charger failure
6. Low battery capacity

H. Components indicated on the drawings shall be located where shown. Components that are required for proper operation, but that are not indicated on the drawings shall be located in mechanical or electrical rooms, at accessible locations within suspended ceilings or at locations for which express permission of the Architect has been obtained.

I. The visual aspect of all components of the system that are exposed to view shall be acceptable to the Architect.

J. Signal Strength Inbound. A minimum inbound signal strength of -95 dBm, or other signal strength as required by the authority having jurisdiction, shall be provided throughout the coverage area and provide a minimum intelligible DAQ of 3.4, as defined in TIA/TSB-88C.

K. Signal Strength Outbound. A minimum outbound signal strength of -95 dBm at the donor site, or other signal strength as required by the authority having jurisdiction, shall be provided from the coverage area and provide a minimum intelligible DAQ of 3.4, as defined in TIA/TSB-88C.

2.4 EQUIPMENT

A. Cabinet: Lockable steel enclosure. Arrange interior components so operations required for testing or for normal maintenance of the system are performed from the front of the enclosure. If more than one unit is required to form a complete control panel, fabricate with matching modular unit enclosure to accommodate components and to allow ample gutter space for field wiring and interconnecting panels.

1. Identify each enclosure with an engraved, laminated, phenolic resin nameplate with lettering not less than 1 inch (25 m) high, wording as directed by Fire Department. Identify individual components and modules within cabinets with permanent labels.

2. Mounting: Surface.

3. All active components including but not limited to repeater, transmitter, receiver, and signal booster components remotely located from the Fire Command center shall be contained in NEMA 4 or NEMA 4X enclosure. Provide tamper switch to monitor all active components.

B. Trouble Alarm: Audible device and strobe light, with silencing switch for audible device only. Include signage adjacent to strobe light with name and phone number of the equipment maintenance contractor.

C. Remote trouble alarms: Dry contact closures rated 120 volts, 20 amperes, for remote trouble alarm indication connection to fire alarm system.

2.5 EMERGENCY POWER SUPPLY

A. General: Components include nickel cadmium battery, charger, and an automatic transfer switch.

1. Battery Nominal Life Expectancy: 7 years, minimum.

B. Battery Capacity: Comply with NFPA and Fire Department requirements. Battery Capacity: Minimum for twenty-four (24) hour supervisory operation followed by full load operation for six (6) hours.

C. Battery Charger: Solid state, fully automatic, variable charging rate type. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge. If batteries are fully discharged, the charger recharges them completely within four hours. Charger output is supervised as part of system power supply supervision.

D. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install system according to standards referred to in Part 1 of this Section.

B. Each outlying component requiring a power supply for its proper operation shall receive this supply over wires extended from the central equipment in a code approved manner.

C. Comply with the applicable requirements of other sections of Division 26 for locating and routing circuitry, for installing circuitry, for firestopping and for identification.

D. Adjust the gain of all amplifiers on the basis of the actual installation in accordance with manufacturer's instructions and Fire Department requirements.

E. Paint the outside parts of all equipment cabinets and all junction boxes, pull boxes and outlet boxes red.

F. Comply with NECA 1.

G. Wiring Method: Install power, control wiring, and non-lossy coaxial cables in raceway. Survivability from attack by fire shall meet NFPA 72 requirements for fire exposure of two (2) hours. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceways and Boxes for Electrical Systems."

H. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools. Connect conductors that are terminated, spliced, or interrupted in any enclosure to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

I. Cable Taps: Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

3.2 EQUIPMENT INSTALLATION

A. Equipment Cabinets: Floor mounted with tops of cabinets not more than 72 inches (183 cm) above the finished floor. No conduit entries from top, all from sides or bottom.

B. The amplifier and associated equipment shall be located in a two (2) hour fire resistance rated room.

3.3 ANTENNA MOUNTING

A. Exterior Antenna: Mount to building structure where indicated. Use mounting arrangement and substrate connection that will resist 100 miles per hour (160 km per hour) wind load with a 1.3 gust factor without damage.

3.4 GROUNDING

A. Ground cable shields and equipment according to system manufacturer's instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.

C. Connect to grounding electrode specified in Division 26 Section "Grounding." Comply with installation requirements of Division 26 Section "Grounding."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

B. Pretesting: After installation, adjust the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

C. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of the witnesses to the preliminary tests.

D. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.

E. Minimum System Tests: Test the system according to the procedures outlined by the Fire Department. Minimum required tests are as follows:

1. Verify an acceptable 2-way radio signal with coverage of 95 97 percent of each floor, and 100% in critical areas.

2. Verify an acceptable 2-way radio signal with coverage in elevator cabs throughout their vertical travel.

3. Test the system for all specified functions according to the approved operation and maintenance manual. Observe indicating lights, displays, signal tones, and annunciator indications.

4. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.

F. Retesting: Correct deficiencies indicated by tests at no additional cost to owner and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion of tests.

H. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

I. Include as part of the base bid quotation the testing and adjustment of the system as needed during the warranty period and the periodic regular testing of system devices to comply with Building Department and Fire Department requirements, during the warrantee period. The first annual testing of the system should be included.

J. In addition to the base bid price quotation, submit separate quotations for each of the "Service Contract" components described hereinafter. It shall be understood that these quotations shall be for a one (1) year period commencing with the expiration of the warrantee period. The "contract" shall be renewable, at the Owner's option, for one (1) year periods up to a total of five (5) years. The renewal contracts shall be based on the original, escalated by the national C.P.I. index. The quotations shall be for the following:

1. Annual Inspection and Test - Provide all material and labor to test all active components of the system, including but not limited to amplifiers, power supplies, and backup batteries. Adjust as required to provide optimum system performance. Parts and labor for repairs and/or replacements is excluded. This service shall be provided at regular intervals complying with the requirements of the Building Department and the Fire Department.

2. Radio Coverage Test - Provide all material and labor to perform a radio coverage test system to ensure that the radio system meets the requirements of the original acceptance test. Adjust as required to provide optimum system performance. Parts and labor for repairs and/or replacements is excluded. This service shall be provided at regular intervals complying with the requirements of the Building Department and the Fire Department.

3. Repairs and Replacement - Provide all labor and parts as necessary to repair and/or replace any and all defective equipment components.

K. If the system is not manufactured locally, but is supplied by a local distributor, the manufacturer shall provide a "letter of support" stipulating that when - in the opinion of the engineer - the distributors efforts require backup, the manufacturer will provide at no cost to the Owner, all required technical support manpower in a timely manner during the installation period, and for a one year warrantee period thereafter.

3.6 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

B. Adjusting: Adjust the system to provide the required radio coverage.

END OF SECTION 26 60 08

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DIVISIONS 27 AND 28 – TELECOMMUNICATION, AUDIO-VIDEO AND SECURITY INDEX

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SECTION 27 00 00 - TELECOMMUNICATIONS CABLING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: This section includes all telecommunications cabling systems and related work described herein.

B. All telecommunications work shown in the drawings and this specification shall be included under the base bid, except where there is specific reference to exclusion and incorporation in other quotations.

C. It is the purpose of these drawings and specifications to bid a complete, warranted cabling system. Multiple manufacturer warranties may apply (e.g. there may be separate warranties for the copper cabling system and the fiber optic cabling system). The Contractor shall submit a proposal and pricing to perform the scope of work outlined in these drawings and specifications.

D. All cables, connectors, faceplates, patch panels, patch cords, termination blocks, cross-connects, racks, cabinets, wire management devices, ladder racks, documentation, etc. shall be provided by the Contractor as outlined in this specification and the associated drawings unless stated otherwise.

E. It is the intent of the drawings and specifications to provide a complete, operating telecommunications system. All telecommunications work necessary to provide such a system shall be performed. Any discrepancies shall be brought to the Engineer's attention.

F. All work included in this section has been configured to be issued as a separate "telecommunications" trade. If any duplicates or conflicts with other specification sections should occur, the item of higher standard shall dictate.

1.2 REFERENCES

A. Reference to General Conditions: The General Conditions shall be considered as forming a part of the specifications and shall be carefully examined before proposals for any work are submitted. Unless the specifications contain statements which are more definitive or more restrictive than those contained in the General Conditions, the specifications shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions.

B. Reference Documents:

1. ANSI/NFPA-70 (2008) - National Electrical Code

2. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises (2009).

3. ANSI/TIA-568-C.1, Commercial Building Telecommunications Cabling Standard (2009).

4. ANSI/TIA-568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standard (2009).

5. ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard (2008).

6. ANSI/TIA-758-A, Customer-Owned Outside Plant Telecommunications Cabling Standard.

7. ANSI/NFPA 75-2003, Standard for the protection of information technology equipment;

8. ANSI T1.336, Engineering requirements for a universal telecommunications frame;

9. ANSI T1.404, Network and customer installation interfaces - DS3 and metallic interface specification;

10. ASHRAE, Thermal Guidelines for Data Processing Environments;

11. Telcordia GR-63-CORE, NEBS (TM) Requirements: physical protection;

12. Telcordia GR-139-CORE, Generic requirements for central office coaxial cable;

13. TIA/EIA-569-B (2004) - Commercial Building Standard for Telecommunications Pathways and Spaces

14. ANSI/TIA/EIA-570-A (2002) - Residential and Light Commercial Telecommunications Wiring Standard

15. ANSI/TIA/EIA-606-A (2002) - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

16. ANSI/ J STD-607A (2002) - Commercial Building Grounding and Bonding Requirements for Telecommunications

17. ANSI/TIA/EIA-758-2004 - Customer-Owned Outside Plant Telecommunications Cabling Standard

18. BICSI TDMM (2006) - Telecommunications Distribution Methods Manual, 11th Edition.

19. ISO/IEC-11801:2002 - Information Technology - Generic Cabling for Customer Premises

C. Organizations:

1. Reference to "ANSI Standards" shall mean the standards published by the American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

2. Reference to "ANSI/TIA/EIA Standards" or "TIA/EIA Standards" shall mean the standards published by the Telecommunications Industry Association (in association with the Electronic Industries Association), 2500 Wilson Boulevard, Arlington, VA 22201.

3. Reference to "Bell Standards" or "Bellcore Standards" shall mean the standards published by Telecordia Technologies (formerly Bellcore), 8 Corporate Plaza #3A 184, Piscataway, NJ 08854-4120.

4. Reference to "BICSI" shall refer to documents published by the Building Industries Consulting Service International, 8610 Hidden River Parkway, Tampa, FL 33637-1000.

5. Reference to "NEMA Standards" shall mean the "Approved Standards" published by the National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209.

6. Reference to "NEC", "National Electrical Code" or "NFPA Standards" shall refer to standards published by the National Fire Protection Association, 1 Battery march Park, P.O. Box 9101, Quincy, MA 02269-9101.

7. Reference to "IEEE Standards" shall mean the standards published by the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331.

8. Reference to "ISO Standards" shall mean standards published by the International Organization for Standardization, 1, rue de Varembe, Case postale 56, CH-1211 Geneva 20, Switzerland.

9. Reference to "OSHA Standards" shall mean the standards published by the Occupational Safety and Health Administration, 200 Constitution Avenue NW, Washington, DC 20210.

10. Reference to "RUS Standards" or "REA Standards" shall mean the standards published by Rural Utilities Services (formerly Rural Electrification Administration), AG-Box 1522, 14th and Independence Avenue SW, Washington, DC 20250.

11. Reference to "U.L. (Materials Construction) Standards" shall mean the "Standards for Safety," published by Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062.

1.3 CODES, PERMITS AND INSPECTIONS

A. All telecommunications work shall meet or exceed the latest requirements of all national, state, county, municipal, and other authorities exercising jurisdiction over the telecommunications work and the project.

B. All required permits and inspection certificates shall be obtained, paid for, and made available at the completion of the telecommunications work. In the event that no official authority exists which will issue a certificate attesting to the compliance of the telecommunications installation, such a certificate may be acquired from an independent agency selected by the Owner. Inspection and certification fees levied by this agency shall be paid for as part of the telecommunications work.

C. Any portion of the telecommunications work which is not subject to the requirements of an electric code published by a specific authority having jurisdiction shall be governed by the National Electrical Code and other applicable sections of the National Fire Code, as published by the National Fire Protection Association.

D. Installation procedures, methods and conditions shall comply with the latest requirements of the Federal Occupational Safety and Health Administration (OSHA).

E. All installations shall be in conformance with the latest revisions of ANSI/TIA/EIA-568-C, 569-A, 606 and 607, as well as all associated addendums and telecommunications systems bulletins (TSB's).

1.4 CONTRACTOR QUALIFICATIONS

A. The Contractor shall be fully conversant and capable in the cabling of voice, data, and CATV facilities and shall at a minimum possess the following qualifications:

1. Personnel trained and certified by the proposed manufacturer to install the proposed warranted cabling solution.

2. Demonstrate experience in installing a minimum of 2 cabling plants of similar size within the same metropolitan area completed within the last 36 months at a single site. The projects shall have been a continuous effort spanning not more than one year each.

3. Certification in fiber optic splicing and connectorization techniques/technologies as well as certification by Corning, OCC, Sumitomo, or other approved manufacturer.

4. Personnel trained in the use of fiber optic OTDR, OLS, and mechanical splicing techniques.

5. Personnel trained in the installation of riser cable plant and experienced with cable support techniques, products, and splicing techniques.

6. Personnel trained in the installation of outside plant cable (both copper and fiber optic) including underground and aerial cable installation and splicing and protection techniques.

7. Experience in the installation of coaxial cabling for the transmission of cable TV broadcasts.

B. Proof of comparable installations is required. The Contractor shall provide documentation and references attesting to their ability to satisfy the following requirements:

1. Technical/Management Capability

a. The Contractor shall demonstrate technical qualification and management capability to supply, install, test, and support the installation and testing of the telecommunications cabling system.

2. Financial Capability

a. The Contractor shall present data to demonstrate financial stability and performance during the last five (5) years.

3. Contractor Experience

a. The Contractor must demonstrate experience and capability in systems of similar size and scope as described above. The Contractor shall provide a list of customers for which similar systems were installed and suitable references with telephone numbers required.

4. Support and Services

a. The Contractor shall guarantee the availability of system hardware/software support, services, repairs and spare parts for up to fifteen (15) years following system acceptance. The Contractor shall indicate the number of its trained service technicians within the metropolitan area of the job site who are knowledgeable in the support/repair of the systems proposed.

5. Qualified Personnel

a. The firm shall have at least one RCDD on staff that shall be dedicated to the project for the duration.

b. The foreman assigned to this project shall be dedicated to the supervision of the cabling infrastructure and associated work only. The foreman shall share in no other responsibilities associated with this project (i.e. electrical foreman). If the electrical and telecommunications cabling contractors are the same firm, a separate foreman shall be assigned to this project for the supervision of each discipline.

c. The resume and project experience of the proposed foreman shall be submitted for review and acceptance as part of the submission. The Owner reserves the right to have a new foreman assigned to this project at any time during the project without explanation.

1.5 DEFINITIONS AND INTERPRETATIONS

A. As used in the drawings and specifications for the telecommunications cabling work, certain non-technical words shall be understood to have specific meanings as follows regardless of indications to the contrary in the General Conditions or other documents governing the telecommunications work:

1. "Furnish" -- Purchase and deliver to the project site complete with every necessary appurtenance and support, all as part of the telecommunications work. Purchasing shall include payment of all sales taxes and other surcharges as may be required to assure that purchased items are free of all liens, claims or encumbrances. Payment of sales taxes, however, is specifically excluded, if applicable.

2. "Install" -- Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project, all as part of the telecommunications work.

3. "New" -- Manufactured within the past two years and never before used.

4. "Provide" -- "Furnish" and "install."

5. "Shall" -- Indicates a mandatory requirement.

B. Regardless of their usage in codes or other industry standards, certain words as used in the drawings or specifications for the telecommunications cabling work shall be understood to have the specific meanings ascribed to them in the following list:

1. "Accessible Corridor" -- A common horizontal pathway that can be approached or entered easily in which telecommunications cables are run until they branch out to individual outlet terminations.

2. “Administration” -- The method for labeling, identification, documentation and usage need to implement moves, additions and changes of the telecommunications infrastructure.

3. "Assembly" -- A defined set of elements of telecommunications work.

4. "Backbone" -- Shall refer to the portion of the installation that transmits between building floors (or between telecommunications rooms). The term "Riser" may also be used interchangeably.

5. “Bonding” -- The permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed.

6. "Bundle" -- Shall refer to multiple cables of similar or dissimilar cable types, as specified. The cables shall be neatly placed and tie wrapped together. The bundle size shall be of practical and manageable proportions.

7. “Cabinet” (Telecommunications) -- An enclosure with a hinged cover used for terminating telecommunications cables, wiring, and connection devices.

8. “Cable” -- An assembly of one or more insulated conductors or optical fibers within an enveloping sheath.

9. “Cabling” -- A combination of all cables, jumper cords, and connecting hardware.

10. "Category 3, 5e, 6" -- Conforming to the guidelines issued as part of ANSI/TIA/EIA-568-C and all associated addendums and bulletins.

11. “Centralized Cabling” -- A cabling configuration from the work area to a centralized cross-connect using pull through cables, an interconnect, or splice in the telecommunications room.

12. “Channel” -- The end-to-end transmission path between two points at which application-specific equipment is connected.

13. "Circuit" -- Any specific run of circuitry.

14. "Circuitry" -- Any telecommunications work which consists of wires, cables, raceways, and/or specialty wiring method assemblies taken all together, complete with associated junction boxes, pull boxes, outlet boxes, joints, couplings, splices, and connections except where limited to a lesser meaning by specific description.

15. “Common Equipment Room” (Telecommunications) -- An enclosed space used for equipment and backbone interconnections for more than one tenant in a building or campus.

16. “Computer Room” -- An architectural space whose primary function is to accommodate data processing equipment.

17. "Concealed" (as applied to circuitry) -- Covered completely by building materials, except for penetrations (by boxes and fittings) to a level flush with the surface as necessitated by functional or specified accessibility requirements.

18. “Connecting Hardware” -- A device providing mechanical cable terminations.

19. “Consolidation Point” -- A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

20. “Cross-Connect” -- A facility enabling the termination of cable elements and their interconnection or cross-connection.

21. “Cross-Connection” -- A connection scheme between cabling runs, subsystems, and equipment using patch cords or jumpers that attach to connecting hardware on each end.

22. "Distribution Frame" -- A system of terminal blocks, patch cords, and backboards that facilitates administration of cross-connect fields for moves and rearrangements.

23. “Data Center” -- A building or portion of a building whose primary function is to house a computer room and its support areas.

24. “Demarcation Point” -- A point where the operational control or ownership changes.

25. “Earthing” -- See grounding.

26. “Electromagnetic Interference” -- Radiated or conducted electromagnetic energy that has an undesirable electronic equipment or signal transmission.

27. "Entrance Point" -- Point at which telecommunications cabling enters the building. Where cable enters in conduit that is buried in a concrete floor, the point at which the conduit emerges from the floor is considered the entrance point.

28. “Equipment Cable/Cord” -- A cable or cable assembly used to connect telecommunications equipment to horizontal or backbone cabling.

29. “Equipment Distribution Area” -- The computer room space occupied by equipment racks or cabinets.

30. "Equipment Room" -- An enclosed area or room specifically designated for housing telecommunications terminations and associated electronics.

31. “Equipment Room” (Telecommunications) -- An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect.

32. "Exposed" (as applied to circuitry) -- Not covered in any way by building materials.

33. “Fiber Optic” -- See Optical Fiber.

34. “Ground” -- A conducting connection, whether intentional or accidental, between an electrical circuit (e.g., telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

35. “Grounding” -- The act of creating a ground.

36. “Grounding Conductor” -- A conductor used to connect the grounding electrode to the building’s main grounding busbar.

37. "Horizontal Cable" -- The portions of the cable installation that are installed between the telecommunications rooms and the work area outlets. The terms "Station Cable" or "Workstation Cable" may also be used.

38. “Horizontal Cross-Connect” -- A cross-connect of horizontal cabling to other cabling, (e.g., horizontal, backbone) or equipment.

39. "IDF" -- Intermediate distribution frame.

40. "IDF Room" - See "Telecommunications Room"

41. “Identifier” - An item of information that links a specific element of the telecommunications infrastructure with its corresponding record.

42. “Infrastructure” (Telecommunications) -- A collection of those telecommunications components, excluding equipment, that together provide the basis support for the distribution of all information within a building or campus.

43. “Interconnection” -- A connection scheme that employs connecting hardware for the direct connection of a cable to another cable without a patch cord or jumper.

44. “Intermediate Cross-Connect” -- A cross-connect between first level and second level backbone cabling.

45. “Link” -- A transmission path between two points, not including terminal equipment, work area cables, and equipment cables.

46. "Low Voltage" -- Less than 50 volts.

47. "MDF" -- Main distribution frame.

48. “Main Cross-Connect” -- A cross-connect for first level backbone cables, entrance cables, and equipment cables.

49. “Media” (Telecommunications) -- Wire, cable, or conductors used for telecommunications.

50. “Modular Jack” -- A female telecommunications connector that may be keyed or unkeyed and may have 6 or 8 contact positions, but not all the positions need be equipped with jack contacts.

51. “Multimode Optical Fiber” -- An optical fiber that carries many paths of light.

52. “Multimode Cable” -- A cable having more than four pairs.

53. “NID” -- Network interface device.

54. "Normal Work Conditions" -- Locations within building confines which are neither damp, wet, nor hazardous and which are not used for air handling.

55. “Optical Fiber” -- Any filament made of dielectric materials that guides light.

56. “Optical Fiber Cable” -- A cabling assembly consisting of one or more optical fibers.

57. “Pathway” -- A facility for the placement of telecommunications cable.

58. "Patch Cord" -- A length of cable that is installed such that it is easily removable. A patch cord is typically connectorized at both ends.

59. "Patch Panel" -- A passive electronic device at which multiple cables are terminated in individual connectors.

60. “Plenum” -- A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.

61. “PBX” -- A private telecommunications switching system.

62. “Pull Box” -- A housing located in a pathway run used to facilitate the placing or pulling of wire or cables.

63. "Raceway" -- Any pipe, duct, extended enclosure, or conduit (as specified for a particular system) which is used to contain wires, and which is of such nature as to require that the wires be installed by a "pulling in" procedure.

64. "Riser" -- See "Backbone"

65. “Screen” -- An element of a cable formed by a shield.

66. “Screened Twisted-Pair (ScTP)” -- A balanced cable with an overall screen.

67. “Service Provider” -- The operator of any service that furnishes telecommunications content (transmissions) delivered over access provider facilities.

68. “Sheath” -- See cable sheath.

69. “Shield” -- A metallic layer placed around a conductor or group of conductors.

70. “Single-Mode Optical Fiber” -- An optical fiber that carries only one path of light.

71. “Singlemode Optical Fiber” -- See Single-Mode Optical Fiber.

72. “Splice” -- A joining of conductors, meant to be permanent.

73. “Star Topology” -- A topology in which telecommunications cables are distributed from a central point.

74. "Standard" (as applied to wiring devices) -- Not of a separately designated individual type.

75. "Station Cable" -- See "Horizontal Cable"

76. "Subject to Mechanical Damage" -- Exposed within seven feet of the floor in mechanical rooms, manufacturing spaces, vehicular spaces, or other spaces where heavy items (over 100 pounds) are moved around or rigged as a common practice or as required for replacement purposes.

77. “Telecommunications” -- Any transmission, emission, and reception of signals, images, and sounds (that is, information of any nature by cable, radio, optical, or other electromagnetic system).

78. “Telecommunications Room” -- The enclosed area or room specifically designated for the routing, termination and/or cross-connecting of telecommunications cable (i.e., backbone cable) to other telecommunications cable and/or equipment (i.e., workstation cables or concentrators/hubs/switches). This may also be referred to as the telephone closet, communications closet, Telecommunications closet, or IDF room.

79. "Telecommunications Wiring" -- See "Circuitry"

80. "Telecommunications Work" -- All telecommunications work as defined by the telecommunications drawings and specifications.

81. "UPS" -- Uninterruptible Power Supply, an auxiliary power unit for telecommunications systems that provides continuous power in the event of a commercial power failure.

82. “Topology” -- The physical or logical arrangement of a telecommunications system.

83. “Wireless” -- The use of radiated electromagnetic energy (e.g., radio frequency, microwave signals, light) traveling through free space to convey information.

84. “Wiring" -- See "Circuitry"

85. "Work Area Outlet" -- See "Workstation"

86. "Workstation" or "Workstation Outlet" -- The point of attachment of voice and/or data end user equipment to the cabling system.

C. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any telecommunications item in the drawings and specifications for telecommunications work carries with it the instruction to furnish, install, and connect the item as part of the telecommunications work regardless of whether or not this instruction is explicitly stated.

D. It shall be understood that the specifications and drawings are complementary and are to be taken together for a complete interpretation of the telecommunications work. Where there are conflicts between the drawings and specifications or within the specifications or drawings themselves, the items of higher standard shall govern.

E. To the extent that they govern the basic work, the specifications also govern change order work if any.

F. No exclusion from, or limitation in, the symbolism used on the drawings for telecommunications work or the language used in the specifications for telecommunications work shall be interpreted as a reason for omitting the appurtenances or accessories necessary to complete any required system or item of equipment.

G. The drawings for telecommunications work utilize symbols and schematic diagrams that have no dimensional significance. The telecommunications work shall, therefore, be installed to fulfill the diagrammatic intent expressed on the telecommunications drawings, but in conformity with the dimensions indicated on the final working drawings, field layouts and shop drawings of all trades.

H. Certain details appear on the drawings for telecommunications work that are specific with regard to the dimensioning and positioning of the telecommunications work. These are intended only for general information purposes. They do not obviate field coordination for individual items of the indicated work.

I. Information as to general construction, architectural general construction, and architectural features and finishes shall be derived from architectural and structural drawings and specifications only.

J. Ratings of devices, materials, and equipment specified without reference to specific performance criteria shall be understood to be nominal or nameplate ratings established by means of industry standard procedures.

1.6 SEPARATION OF WORK BETWEEN TRADES

A. The specifications for overall construction delineate various items of work under separate trade headings. The list below sets forth this delineation to the extent that it affects the telecommunications work.

B. In the absence of more detailed information, the list shall be taken as a specific instruction to the Telecommunications Trade to include the telecommunications work assigned to it.

C. Indications that any trade is to perform an item of work means that trade is to perform the telecommunications work for its own accommodation only, except as specifically noted otherwise.

D. Oth = Other than the Electrical or HVAC trades.

Plb = Plumbing

HVAC = Heating, Ventilating & Air Conditioning

Elec = Electrical

Comm = Telecommunications

F = Furnish

I = Install

P = Provide (furnish and install)

Item	**Oth**	**Plb**	**HVAC**	**Elec**	**Comm**	**Notes**
Temporary light and power	P					See General Conditions Specifications.
Temporary water	P					To accommodate all trades
Temporary heat	P					
Hoisting					P	
Rigging					P	
Bracing and dunnage for safe rigging					P	
Cutting chasing and patching	P					Cost, where due to late installation or improper coordination of work, is the responsibility of the telecommunications cabling contractor.
Framed slots and openings in decks and slabs	P					Coordination drawings of openings are required from the telecommunications cabling contractor.

Item	Oth	Plb	HVAC	Elec	Comm	Notes
Sleeves through non-waterproof slabs, decks and walls				P		Includes drilling of holes when required. Coordination drawings are required from the telecommunication cabling contractor where sleeves are provided for telecommunications cabling work.
Sleeves through waterproof slabs, decks, and walls				P		Includes drilling of holes other than field-poured concrete. Coordination drawings are required from the telecommunications cabling contractor where sleeves are provided for telecommunications cabling work.
Waterproof sealing of sleeves through waterproof slabs, decks, and walls				P		
Fireproof sealing (Firestopping) of excess opening spaces in slabs, decks and fire-rated walls					P	
Excavation and backfill inside buildings	P					
Excavation and backfill outside buildings	P					
Fastenings					P	
Supports					P	
Telecommunications manholes and handholes	P					Furnishing of frames and other hardware shall be included in the telecommunications cabling work.
Cable support in equipment rooms				P		Vertical cable support to cable tray at ceiling is included in the telecommunications cabling work.
Empty conduit and raceways for routing				P		Raceways for routing and protecting telecommunications cabling in closets and equipment rooms is included in the telecommunications cabling work.

Item	Oth	Plb	HVAC	Elec	Comm	Notes
Concrete encasement of conduits				P		
Flashing of telecommunications conduits through roof (pitch pockets)	P					
Concrete lined trenches in building foundation	P					
Field touch-up painting of damaged shop coats					P	
Field rustproof painting of supporting steel members, frames and racks					P	
Finish painting of exposed work	P					
Finished wall and ceiling access doors, panels and frames	P					Supplying list of locations where required is included in the telecommunications cabling work.
Finished wall and ceiling access doors, panels and supporting frames	P					Supplying list of locations where required is included in the telecommunications cabling work.
Cellular decking	P					Supplying list of locations where required is included in the telecommunications cabling work.
Permanent catwalks to equipment	P					Supplying list of locations where required is included in the telecommunications cabling work.
Permanent ladders to equipment	P					Supplying list of locations where required is included in the telecommunications cabling work.
Rubbish removal					P	Removal of the shipping and packing materials of telecommunications items is included in the telecommunications cabling work, regardless by whom the items are furnished.
Special tools for maintenance of equipment furnished as part of telecommunications cabling work					F	A minimum of one (1) set of tools (i.e. punchdown tools) shall be provided for each type of termination.

Item	Oth	Plb	HVAC	Elec	Comm	Notes
Grounding of telecommunications related equipment, frames, racks, protectors, etc.					P	Ground bars may be provided as part of the electrical work for use by the telecommunications cabling contractor.

E. Include in the telecommunications work all necessary supervision and the issuing of all coordination information to any other trades who are supplying work to accommodate the telecommunications installations and those trades that utilize the telecommunications cabling system as a distribution means.

F. For items of equipment which are to be installed but not purchased as part of the telecommunications work, the telecommunications work shall include:

1. The coordination of their delivery.

2. Their unloading from delivery trucks driven in to any point on the property line at grade level.

3. Their safe handling and field storage up to the time of permanent placement in the project.

4. The correction of any damage, defacement, or corrosion to which they may have been subjected.

5. Their mounting in place, including the purchase and installation of all dunnage, supporting members, and fastenings necessary to adapt them to architectural and structural conditions.

6. Included shall be the purchase and installation of any substitute lugs or other wiring terminations as may be necessary to adapt their terminals to the wiring as called for and to the connection methods set forth in these specifications.

G. Items of equipment which are to be installed but not purchased as part of the telecommunications work shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the telecommunications work will be considered only if presented in writing within one week of the date of delivery to the project of the items in question. The telecommunications work includes all procedures, regardless of how extensive, necessary to put into satisfactory operation all items for which no claims have been submitted as outlined above.

H. Where cabling is specified to be provided by the Owner or his representative, the following shall be performed: Prior to the ordering of cabling, the Contractor shall identify the cable types, quantities, and lengths required and provide them to the Owner to be ordered. It is the Contractor's responsibility to ensure that the information is complete and accurate. Any errors or omissions in the ordering information will be the Contractor's responsibility.

1.7 SUBMITTALS AND SHOP DRAWINGS

A. Prior to purchasing any equipment or materials, a list of their manufacturers shall be submitted for review.

B. Prior to assembling or installing the telecommunications work, the following shall be submitted for review:

1. Catalog information, factory assembly drawings and field installation drawings as required for a complete explanation and description of all items of equipment.

2. Submit for approval one sample of each of the following:

a. Each type of cable.

b. Each type of cable connector.

c. Each type of wiring device plate, complete with labeling.

d. Each type of patching/cross connecting device.

e. Each type of protector.

f. Each type of identification label.

g. Other items as requested.

C. Documents will not be accepted for review unless:

1. They include complete information pertaining to appurtenances and accessories.

2. They are submitted as a package where they pertain to related items.

3. They are properly marked with specific service or function, and intended location of use within the project (e.g., "backbone cabling", "telecommunications room").

4. They are clearly identified or highlighted to indicate all items that are applicable.

5. They indicate the project name and address along with the Contractor's name, address, and phone number.

D. Shop Drawing Review

1. The purpose of the review of shop drawings is to maintain the integrity of the design. Unless the Contractor clearly points out changes, substitutions, deletions, or any other differences between the submission and the Contract Documents in writing on the Contractor's letterhead, approval by the Engineer or Architect does not constitute acceptance. It is not to be assumed that the Engineer has read the text or reviewed the technical data of a manufactured item and its components except where the Vendor has pointed out differences between his product and the specified model.

2. It is the responsibility of the Contractor to confirm all dimensions, quantities, and the coordination of materials and products supplied by him with other trades. Approval of shop drawings containing errors does not relieve the Contractor from making corrections at his expense.

3. Substitutions of equipment, systems, materials, etc. must be coordinated by the Contractor with his own or other trades which may be involved with the item, such as, but not limited to, equipment substitutions which change telecommunications or electrical requirements, or hanging or support weights or dimensions.

4. Any extra charges or credits which may be generated by other trades due to substitutions will not be accepted unless the Contractor has an agreement in writing with the Owner.

5. Substitutions of equipment, systems, etc. requiring approval of local authorities must comply with such regulations and be filed at the expense of the Contractor (should filing be necessary). Substitutions are subject to approval or disapproval by the Engineer. The Contractor, in offering substitutions, shall hold the Owner and Engineer harmless if the substituted item is an infringement of patent held by the specified item.

6. The following shop drawings shall be submitted to the Engineer for review, minimum:

    a. Coordinated wallfield elevations for the main equipment room and each telecommunications room identifying the dimensions of all termination hardware provided by the Contractor and all devices provided by other trades.

    b. Coordinated floor plans of the main equipment room and each telecommunications room identifying the dimensions of all racks, cabinets, and other equipment provided by the Contractor and by other trades.

    c. Coordinated ceiling plans of the main equipment room and each telecommunications room identifying the dimensions of all ladder rack, light fixtures, sprinkler heads, wall openings, sleeves etc.

    d. Drawings showing conduit and sleeve allocation and fill.

E. Explanation of Shop Drawing Stamp

1. “Approved” indicates that we have not found any reason why this item should not be acceptable within the intent of the documents.

2. “As Noted” indicates that we have found questionable components which if corrected or otherwise explained make the product acceptable.

3. “Resubmit” indicates that this item should be resubmitted for approval before further processing.

    a. If both "As Noted" and "Resubmit" are checked, the resubmittal is for record purposes only.

4. “Not Accepted” indicates that the item will not meet the intent of the Contract.

5. No shop drawing stamp or note shall constitute an order to fabricate or ship. Such notification can only be performed by the Project Manager for Construction, the Contractor scheduling his own work, or the Owner.

F. Include in the telecommunications work the issuing of maintenance and operating instructions for the following specialized equipment:

1. All electronic equipment, if any, provided or installed as part of the telecommunications work.

G. The issuing of operating instructions shall include all original operating and maintenance instruction manuals.

H. The issuing of operating instructions shall include the supplying of qualified personnel to demonstrate the operation of specialized equipment.

I. The issuing of operating instructions shall include the submission of the name, address, and telephone number of the manufacturer's representative and service company for each item of equipment, so that service and spare parts can be readily obtained.

J. After all final tests and adjustments have been completed, fully instruct the proper Owner's Representative in all details of operation for equipment installed. Supply qualified personnel to operate equipment for sufficient length of time to assure that Owner's Representative is properly qualified to take over operation and maintenance procedures. Supply qualified personnel to operate equipment for sufficient length of time as required to meet all governing authorities in operation and performance tests.

K. Furnish required number of manuals, in bound form, containing data covering capacities, maintenance of operation of all equipment and apparatus. Operating instructions shall cover all phases of control and include the following:

1. Performance Criteria: For transmission and other equipment as requested.

2. List of Spares: Recommended for normal service requirements.

3. Parts List: Identifying the various parts of the equipment for repair and replacement purposes.

4. Instruction Books may be standard booklets but shall be clearly marked to indicate applicable equipment.

5. Wiring Diagrams: Generalized diagrams are not acceptable--submittals shall be specifically prepared for this Project.

1.8 RECORD DRAWINGS AND AS-BUILT DOCUMENTATION

A. As part of the required telecommunications work, a complete set of "as-built" or record telecommunications drawings shall be generated and delivered to the Engineer.

B. The drawings shall show:

1. All telecommunications work installed in accordance with the original design.

2. All telecommunications work installed as a modification or addition to the original design.

3. The dimensional information necessary to delineate the exact location of all circuitry and wiring runs that are concealed as to be untraceable by inspection through the regular means of access established for inspection and maintenance.

4. The numbering information necessary to correlate all telecommunications items (or outlets for same) to the patch panel, end user, or head end device to which they are connected.

C. The Contractor shall provide system drawings that include pin configurations, cable runs, terminal blocks, conduit, systems/materials, riser diagrams, and outlet or other terminations. The Contractor shall keep all documentation current throughout the installation and build-out process. If changes occur which affect any documentation, the Contractor shall formally re-issue the affected documentation to the Owner or his representatives.

D. The as-built drawings shall be produced using AutoCAD 2010, or later version.

E. Another CAD program may be utilized as the as-built drawing package of choice, subject to review and approval by the Architect and Owner as to the specific package, version, etc., to be used.

F. The number of design drawings which are made available shall in no way be interpreted as setting a maximum limit to the number of drawings necessary to show the required "as-built" information. The number of design drawings shall, however, be the minimum number of drawings required in the "as-built" submission.

G. Any and all costs for document conversion (if necessary), printing, etc., are the responsibility of the Contractor.

H. Design drawings will be made available in AutoCAD 2010, for the exclusive purpose of producing "as-built" drawings. These documents remain the property of Cosentini Associates and shall be used for no other purpose without expressed, written consent. The Contractor shall assume all liabilities resulting from unauthorized modifications to the drawings.

I. All manufacturer's product data including specifications and installation instructions will be provided to the Owner upon acceptance of the space by the Owner and Engineer.

J. The Contractor shall provide copies of all test documentation according to the requirements listed elsewhere in the specifications.

K. The "as-built" documentation package submitted to the Engineer for approval shall contain the following:

1. A complete set of "as-built" drawings in the following formats:

a. CAD drawing files (“.dwg” format)

b. PDF files (.pdf format)

2. Cross-connect information in the following formats:

a. Excel compatible files

3. Cable record database in the following format:

a. Excel compatible files

4. Manufacturer's product data in the format provided by the manufacturers.

5. Cable test results formatted as described elsewhere in the specifications.

1.9 QUALITY ASSURANCE

A. All equipment and materials for permanent installation shall be the products of recognized manufacturers and shall be new.

B. New equipment and materials shall:

1. Be Underwriters Laboratories, Inc. (U.L.) labeled and/or listed where specifically called for, or where normally subject to such U.L. labeling and/or listing services.

2. Be clearly labeled identifying the transmission parameters specified (specifically with reference to Category 6 or higher ratings).

3. Be without blemish or defect.

4. Be in accordance with the latest applicable standards.

5. Be products that meet with the acceptance of the Engineer.

C. All items of equipment or material of one generic type shall be the product of one manufacturer throughout.

D. It is the intent of these specifications that wherever a manufacturer of a product is specified, and the terms "other approved" or "approved equal" or "equal" are used, the substituted item must conform in all respects to the specified item. Consideration will not be given to claims that the substituted item meets the performance requirements with lesser construction. Performance as delineated in schedules and in the specifications shall be interpreted as minimum performance.

E. Substitutes for items that are required to meet industry standards shall meet or exceed the requirements of those standards in all respects.

F. Substituted equipment or optional equipment where permitted and approved, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether approved or not, shall be replaced at the Contractor's expense. Any modifications of related systems as a result of substitutions shall be made at the Contractor's expense.

G. All proposed substitutions must be presented to the Owner/Engineer for review and approval as stipulated elsewhere.

H. The approval of shop drawings or other information submitted in accordance with the requirements herein specified does not ensure that the Engineer, Architect, or any other Owner's Representative attests to the dimensional accuracy or dimensional suitability of the material or equipment involved, the ability of the material or equipment involved, or the mechanical performance of equipment. Approval of shop drawings does not invalidate the plans and specifications if in conflict, unless a letter requesting such change is submitted and approved on the Engineer's letterhead.

I. Substitutions of telecommunications materials for that shown on the schedules or designated by model number in the specifications will not be considered if the item is not a regular catalogued item shown in the current catalog of the manufacturer.

J. The Contractor shall be responsible for insuring that the installation of all equipment be performed in accordance with manufacturers' specifications. The necessity of special conditions required by a particular manufacturer shall be brought to the attention of the Engineer prior to the installation of any equipment in the area concerned.

K. The Contractor shall provide a complete fit-out of one (1) of the telecommunications rooms for review by the Engineer and Owner prior to continuing with the installation of other telecommunications rooms. The room fit-out shall include all cable terminations, blocks, patch panels, frames, labels, etc. Changes or adjustments required in other telecommunications rooms as a result of the review of the fit-out room shall be the responsibility of the Contractor. The Engineer and the Owner shall be given a minimum of one (1) week notice for the review of the room.

1.10 PROJECT MANAGEMENT

A. The Contractor shall issue weekly progress updates indicating the progress of construction and adherence to the schedule. In addition, the Contractor shall list outstanding items required to be completed by other trades that effect the schedule for the telecommunications cabling work.

B. Any questions arising during installation shall be submitted in writing to the Construction Manager.

C. The Contractor shall designate a site foreman to act as the single point of contact for all issues arising in the field during the course of construction. The duties of the foreman shall include the following:

1. The foreman shall be present for all coordination meetings as directed by the Construction Manager.

2. During the course of construction, the foreman shall be prepared to answer questions regarding progress, workmanship, approvals required, delivery of material, and other subjects concerning the telecommunications cabling work.

3. The foreman shall have a complete set of the most current construction documents (drawings, specifications, and field sketches) on site and available for inspection at any time as requested by the Owner or Engineer.

1.11 GUARANTEES AND CERTIFICATIONS

A. All telecommunications work shall be guaranteed to be free from defects. Any defective materials or workmanship, as well as damage to the telecommunications work of all trades resulting from same, shall be replaced or repaired as directed for the duration of stipulated guarantee periods.

B. The duration of guarantee periods following the date of acceptance of the telecommunications work shall be:

1. For work not otherwise specified -- One (1) year.

2. For items installed as part of a manufacturer's warranty -- Fifteen (15) years, minimum.

C. The date of acceptance shall be the date of the final payment for the telecommunications work or the date of a formal notice of acceptance, whichever is earlier.

D. Manufacturer’s certification shall be submitted attesting to the fact that specified performance and other criteria are met by all items of telecommunications work for which such certification is required.

1.12 UNIT PRICE QUOTATIONS

A. Submit separate unit price quotations for each of the various items hereinafter listed. Unit prices shall include overhead, profit, insurance, and taxes.

B. Unit price quotations shall be suitable both for additions and deductions.

C. Except where specific exceptions are indicated, it shall be understood that equipment, materials, installation methods, etc., required for unit quotation items are to be identical to those called for under the base bid.

D. Unit price quotations shall, in each case, be for complete work, furnished and installed, unless otherwise noted.

E. Itemized list of items for which unit price quotations are required is as follows:

Item No. 1 The provision of each type of tenant outlet (i.e., TV, phone, data, etc., wall/floor mounted) including, but not limited to:

Horizontal cabling (100' avg), connectors, faceplates, closet termination equipment, patching, etc.

Item No. 2 The provision of each type of back-of-house outlet (1-port, 2-port, etc., wall/floor/ceiling mounted) including, but not limited to:

Horizontal cabling (100' avg), connectors, faceplates, closet termination equipment, patching, etc.

Item No. 3 Each item listed in section entitled "Material List".

Item No. 4 Each type of patch cord required or as indicated on the design drawings (lengths to be determined by the Contractor).

F. In addition, provide unit quotations to cover authorized additional telecommunications work performed on a "Time and Material" basis as follows:

Labor -- per man hour.

Regular Working Hours Labor -- for one man working one hour during the stipulated time.

Overtime Labor -- for one man working one hour during the stipulated time.

Material -- percentage to be applied to actual cost.

1. Unit prices for labor shall include all supervision, insurance, overhead, and profit.

2. Quotations for labor shall be accompanied by a schedule denoting the times for which the various indicated rates are applicable.

1.13 ALTERNATE PRICE QUOTATIONS

A. Submit a separate price quotation for changes to the base bid telecommunications work for each alternate as described hereinafter.

1. Refer to drawings for alternate pricing notes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. It is the intent of these drawings and specifications to bid a complete warranted cabling solution. Where necessary, multiple manufacturer cable warranties may apply.

B. The contractor shall propose a solution based upon the warranted cabling solution from one of the following approved manufacturer partnerships: Hubbell/Mohawk.

C. Horizontal voice/data cabling and all associated components (i.e. jacks, faceplates, patch panels, patch cords, etc.) shall be products included in one of the following manufacturer's warranted solutions:

1. Cables and accessories: Mohawk.

2. Connectivity components (RJ-45 Jacks, Faceplates, Patch Panels, etc.): Hubbell.

2.2 FIBER BACKBONE (RISER) CABLING SYSTEM

A. Fiber optic backbone cabling and all associated components (i.e. Cabling, connectors, enclosures, connector panels etc.) shall be products included in one of the following manufacturer's warranted solutions:

1. Mohawk

B. Fiber optic backbone cabling system:

1. Fiber optic riser cabling may be one of the following types:

a. 50/125 micron, 850nm – 1300nm multimode OM3 fiber optic cable (capable of 10 Gb at 300m).

b. Singlemode fiber optic cable.

2. Fiber optic backbone cabling shall comply with NEC section 770 and shall be OFNR rated, minimum, unless otherwise noted.

3. Fiber optic backbone cabling shall terminate in rack mounted, cabinet mounted, or wall mounted patch panels or enclosures as indicated on the drawings. Patch panels or enclosures for fiber optic backbone cabling shall be of a type designed specifically for the termination of fiber optic cabling.

4. Fiber optic backbone cabling shall contain no metallic elements.

C. All backbone cabling shall be installed as indicated on the drawings. All work shall be in accordance with the standards identified in this specification and with industry standards.

D. All multimode fiber optic cable shall be graded-index optical fiber waveguide with nominal 50/125m core/cladding diameter. The fiber shall meet or exceed EIA/TIA - 568B specifications. Laser-based performance shall be up to 300 meters for 10 Gb/s Ethernet standard - compliant links.

E. The fiber optic cable shall contain the following minimum transmission performance parameters:

Maximum Wavelength (nm)	Capacity (dB/Km)	(MHz.Km)
850	3.75	500
1300	1.0	500

Operating Temperature: -40°F to 170°F (-40° to 77°C)

F. The total optical attenuation through the cross-connect from any terminated fiber to any other terminated fiber shall not exceed 1.0 dB.

G. No fiber optic cable shall be run unprotected. Fiber optic cable shall be protected as follows:

Location	Method of Protection
Accessible ceiling spaces	Innerduct or armored fiber (plenum as required)
Non-accessible ceiling spaces	Conduit
Exposed	Innerduct
Within cabinets and on racks	Innerduct or spiral wrapped buffer tubes

H. Innerduct used for fiber optic cable shall be corrugated and bright orange or white in color.

I. All raceways containing fiber optic cable shall be provided with a label "Caution - Fiber Optic Cable" located on the raceway every 20 feet, minimum.

J. All fiber strands are to be terminated with fusion splice type connectors. The fiber and connector performance of the pigtail shall be the same as the fiber it is being fusion spliced to, i.e. OM3 MM fiber or low water peak SM fiber. All splices are to be installed with shrink tube strain relief bars and splice cartridges.

K. The fiber optic connector type is to be LC. All connectors shall sustain a minimum of 1000 mating cycles without violating the specification requirements. The maximum optical attenuation per each mated connector pair shall not exceed 0.5 dB.

L. All fiber optic patch panels or enclosures shall be front and rear accessible where rack or cabinet mounted or front accessible with slide out shelving where wall mounted. They shall have cable guides for routing of cable within the patch panel/enclosure housing. They shall have labels clearly identifying each cable termination.

M. All fiber optic cables shall be provided with strain relief where they enter patch panel housings.

2.2 COAXIAL BACKBONE (RISER) CABLING SYSTEM (IF APPLICABLE TO PROJECT)

A. Coaxial backbone cabling and all associated components (i.e. Cabling and connectors, etc.) shall be products included in one of the following manufacturer's warranted solutions:

1. Commscope, Belden

B. Coaxial riser cabling may be one of the following types:

1. RG-11 Commscope Part Number 2287K Coaxial cable (Or approved equal).

2. Rigid Hard Line Coaxial Cable Commscope Part Number P3-500 (Or approved equal).

C. The coaxial cable shall be as specified on the drawings. The cabling system shall achieve an overall system performance of up to 2000 Megahertz for CATV/MATV and up to 2000 Megahertz for DSS.

D. The Cabling Contractor shall provide a complete and operable cable television infrastructure, with the exception of the active and passive CATV distribution components (to be provided and installed by others).

E. The coaxial backbone cabling infrastructure is the full responsibility of the Cabling Contractor in its entirety. Work performed by the cabling contractor in coordination with the work performed by the Cable TV System Integrator shall provide the Owner with a fully operational cable system that meets or exceeds FCC and industry standards for performance and workmanship.

F. The Contractors shall provide the calculation of all actual cable run-lengths to confirm lengths shown on design drawings, allowing for signal level balancing based on installed field conditions.

G. The required cable system performance is based in part on the Structure Return Loss (SRL) of the specified and installed coaxial cables. The Cable TV cabling shall acquire and ascertain the SRL specifications for the cables. The installed system shall meet or exceed the nominal cable SRL performance characteristics, and any defects which impact the SRL for any and all cables shall be corrected at no further cost to the owner.

H. Final installed cabling shall conform to all current Proof or Performance Testing and Certifications for installed and terminated vertical and horizontal cables based on FCC Title 47 Subpart K, Section 76, and National Cable Television Association standard methods. The installed cable infrastructure shall meet or exceed the cable manufacturer's specifications for Structure Return Loss. The Proof of Performance Testing and Certification shall occur following the Cable TV System Integrators' completion of all installed active and passive CATV components. Proof of Performance Testing and Certification shall be done by the Cable TV Systems Integrator and is not included in the Cabling Contractor's scope of work.

I. The Cable TV Cabling Contractor is responsible to rectify, replace, and/or repair any cabling section, segment, jumper connection, termination or otherwise that is related to non-compliance test results for Proof of Performance and Certification as reported by the Cable TV Systems Integrator following installation of active and passive CATV components and hardware. All Cable TV Cabling and related Cable TV Cabling Contractor scope or work corrections shall be made at no cost to the owner.

J. All cables shall be home run with no splices unless otherwise approved. The contractor may not, without prior approval, use in-line splices of cable segments to correct a problem cable.

2.3 TELECOMMUNICATIONS OUTLET CABLING

A. Horizontal cabling for front-of-house and back-of-house spaces shall be home-run from each designated telecommunications outlet location to the floor-serving telecommunications room.

B. Each telecommunications outlet location is indicated on the drawings by a telecommunications symbol. The contractor shall provide cabling, jacks, faceplates, labels, testing, etc. as described in this section for each and every location identified by a telecommunications outlet symbol.

C. Front-of-house and back-of-house telecommunications outlets shall be one of the following types:

1. Standard voice outlet (wall or wallplate mounted)

a. A standard voice and/or data outlet shall consist of the following:

(1) One (1) individual 4-pair Category 6 UTP cable for voice (4 twisted pair #23 AWG).

(2) At the outlet end, the Category 6 cable shall be terminated on an individual RJ-45 jack following the T568B wiring scheme. In the telecommunications room, the cable shall be terminated on an individual RJ-45 jack following the T568B wiring scheme and mounted on a patch panel.

2. Standard voice/data outlet (1-port, 2-port, etc.; wall/floor/furniture mounted)

a. A standard voice/data outlet shall consist of the following:

(1) Individual 4-pair Category 6 cables for voice/data (4 twisted pair #23 AWG). Refer to design drawings for exact quantities of cables per outlet.

(2) At the outlet end, each 4-pair Category cable shall terminate on individual RJ-45 jacks following the T568B wiring scheme. In the telecommunications room, each cable shall be terminated on an individual RJ-45 jack following the T568B wiring scheme and mounted on a patch panel.

3. Standard wireless access point outlet

a. A standard wireless access point outlet shall consist of the following:

(1) Two (2) individual 4-pair Category 6A UTP cables for data (4 twisted pair #23 AWG).

(2) At the outlet end, each 4-pair Category cable shall be terminated on individual RJ-45 jacks following the T568B wiring scheme and mounted to a surface mount box (biscuit box). At the telecommunications room, each 4-pair Category cable shall be terminated on individual RJ-45 jacks following the T568B wiring scheme and mounted on a Category 6A patch panel.

B. Horizontal cabling (for front-of-house and back-of-house) may terminate in one of the following locations:

1. Wall mounted box.

2. Floor flush or surface mounted poke-thru, floor box, or service fitting.

3. Modular furniture mounted raceway.

4. Surface mounted raceway (e.g. G4000).

5. Ceiling mounted surface mount box (biscuit box).

C. Horizontal cabling containing multiple cables under a single cable identification shall be considered a single entity even though it may emanate or terminate in more than one patch panel or faceplate.

D. Each cable in a standard outlet shall be identified with the same cable ID and a separate description identifying the particular cable (i.e., D1, D2, etc.).

E. Cabling to furniture mounted outlets (if applicable) shall terminate in faceplates mounted on the furniture system raceway where available. Knockouts in the furniture system raceway shall be provided by the cabling contractor where not included as part of the furniture system. All cabling shall be routed via the furniture system raceway. Coordinate all telecommunications work with the furniture system vendor. All cabling feeds from an outlet box into the furniture system raceway or surface raceway shall be protected using corrugated loom tubing or equal. Where no opening is provided in the furniture raceway by the furniture vendor for entrance of the communications cable into the raceway, it shall be provided by the cabling contractor.

1. All necessary protection for the cabling shall also be provided. The contractor shall provide the necessary connectors and faceplates (as described elsewhere). The type of faceplate to be used shall be coordinated with the architect for color, finish, etc. Where the furniture system does not contain an integral raceway, and no apparent wire management method is provided, the cabling shall be neatly dressed and concealed. Installation acceptance shall be based upon review and approval by the engineer.

F. Cabling to standard wall mounted outlets shall terminate in a double-gang back box with a single gang reducer plate, provided by others. The Contractor shall provide the necessary connectors (as described elsewhere) under a single-gang faceplate. The faceplate to be used shall be coordinated with the Architect for type, color, finish, etc.

G. Cabling to floor mounted outlets shall be terminated in a flush or surface mounted poke-thru, floor box, or service fitting provided by others. All cabling and connectors shall remain within the poke-thru, floor box, or service fitting housing. The Contractor shall provide the necessary connectors (as described elsewhere) under a faceplate which is coordinated with the poke-thru, floor box, or service fitting provided. If necessary, the Contractor shall modify the blank plates provided with the poke-thru, floor box, or service fitting in order to accommodate the connectors. All connectors, jacks, ports, etc. shall be provided with blanking or protective covers for protection.

H. For twisted pair cabling, the Contractor shall maintain the minimum number of twists per foot as prescribed for the particular cable. The twists shall be maintained to within 0.5" of the cable termination.

I. All twisted pair cables shall terminate in vapor tight, insulating displacement type connectors (IDC).

J. All terminations for horizontal twisted pair cabling shall conform to the TIA/EIA T568B wiring standard. This wiring scheme shall be maintained throughout the installation (i.e. for all outlets, patch panels, etc.), unless otherwise noted.

K. The Contractor shall confirm that sufficient space exists within the outlet box/raceway and that strain relief is provided for all cable terminations.

L. Horizontal cabling that routes exposed (i.e., not in conduit) shall be neatly bundled and tie wrapped at 4' intervals, minimum, using nylon tie wraps. Tie wraps shall be rated for use in plenum spaces as required.

M. The Contractor shall label each cable and faceplate as described elsewhere in this specification.

N. The Contractor shall test each and every telecommunications outlet and provide test documentation according to the testing procedures described elsewhere in this specification.

2.3 CROSS-CONNECTS AND PATCH CORDS

A. The Contractor shall furnish one (1) Category 6 or 6A patch cord per terminated port for patching between patch panels and network equipment in each telecommunications room. Patch cords shall vary in length as required to ensure a neat and orderly installation.

B. The Contractor shall furnish one (1) Category 6 or 6A patch cord per terminated port for patching between workstation outlets and end user equipment at each back of house telecommunications outlet. Patch cords shall vary in length as required to ensure a neat and orderly installation.

C. The Contractor shall furnish and install one (1) 50/125nm OM3 multimode duplex fiber optic patch cord per terminated fiber optic port for patching between fiber patch panels and network equipment in each telecommunications room. Patch cords shall vary in length as required to ensure a neat and orderly installation.

D. All patch cords shall be of the same manufacturer and cable quality as the cable to which they are connecting.

E. All patching shall be as directed by the Owner or his representative after network equipment vendor selection. It shall be understood that the quantities presented above represent an allocation which can be reconfirmed by the Owner prior to purchase. The cabling contractor shall make recommendations as to the required patch cord lengths to meet these objectives.

F. All patch panel cross-connects shall be performed starting from patch panel or equipment port number one and continuing in consecutive order to the maximum extent possible.

G. Cross-connects and patching connection records shall be provided by the Contractor as specified elsewhere.

H. The Contractor shall neatly dress all patch cords. The Contractor shall provide velcro tie-wraps to neatly bundle patch cords.

2.4 PATCH PANELS

A. Patch panels shall be standard flat 19" rack mountable panels unless specified otherwise.

B. Patch panels shall be labeled in the front and rear with the port number and cable ID.

C. A strain relief bar shall be provided with each patch panel regardless of whether it is indicated on the drawings.

D. Each cable terminated on the rear of a patch panel shall be provided with strain relief.

E. All patch panels shall be rated to the same transmission quality (i.e., category 6 or 6A UTP) as the workstation and/or tie cables which they terminate.

F. Each patch panel installed shall be provided with horizontal wire management panels mounted above and below the patch panel.

G. All patch panels shall be grounded in accordance with requirements listed elsewhere in this specification.

H. Wall mounted patch panels shall be provided with hinged frames or wall mounted enclosures that swing out to provide rear access to the patch panel terminations.

I. For patch panels mounted on hinged frames or wall mounted swing gate racks/enclosures that swing out, cables shall approach the rear of patch panels from the hinged side to allow the patch panel to swing out freely after all cables have been terminated.

J. If plastic jack icons are available for the specified patch panel, the Contractor shall provide icons for each and every port. The icon type and color shall be as indicated on the drawings or as directed by the Owner or the Engineer.

2.5 EQUIPMENT CABINETS

A. Equipment Cabinets, if applicable, shall be consistent with size and quantity shown on drawings.

B. A grounding kit shall be provided with each cabinet for grounding all metal portions of the cabinet. The Contractor shall provide one (1) #6 AWG ground wire from each cabinet to the telecommunications ground bar.

C. A minimum of two (2) fixed shelves shall be provided as part of each cabinet unless specified otherwise. All shelves supplied with equipment cabinets shall be 4-point fixed type and shall be designed to support a static load of 100 lbs., minimum.

D. Cabinets mounted sided by side shall be bolted together.

E. Cabling run in equipment cabinets shall be routed vertically and horizontally in a squared-off manner. The cables shall be secured to the cabinet framing members with Velcro cable ties. All cables connected to an item of equipment or patch panel shall approach the device from the door hinge side of the cabinet (i.e., right or left). The cables shall be neatly bound and dressed.

1. Sufficient slack shall be left on cables in equipment cabinets to allow a device to be relocated anywhere within the cabinet.

2. For cabinets mounted in equipment rooms with raised floor, cabling which runs between cabinets shall be via the raised floor, unless specified otherwise. For cabinets mounted in equipment rooms without raised floor, cables run between cabinets shall be run at the top or bottom along the back of the cabinet or in cable tray or ladder rack mounted above the cabinet (as directed).

3. A minimum of 3'-0" clear shall be maintained in front and behind cabinets. Cabinet doors shall open toward the nearest wall when the cabinet is located within 5'-0" of the wall.

4. Where multiple runs of small diameter cabling are installed vertically within cabinet enclosures (i.e., between patch panels and/or equipment), they shall be run in panduct L or C type raceway fastened to cabinet framing members. Raceways shall be sized as required.

5. Each cabinet shall be labeled as described elsewhere in this specification.

2.6 EQUIPMENT RACKS

A. Equipment racks shall be of standard 19" mounting dimension.

B. Free standing equipment racks shall be the product of one of the following: CPI, Middle Atlantic, Hoffman, or Ortronics.

C. Wall mounted swing gate racks shall be the product of the following manufacturer: CPI.

D. Free standing equipment racks shall have 45 usable rack units (RUs) and be 84" high. Interstitial spaces shall be 66" high.

E. Wall mounted swing gate racks shall have 41 usable rack units (RUs) and be 73.5” high.

F. Free standing equipment racks shall have 6" deep channels, unless specified otherwise.

G. Free standing equipment racks shall be provided with a standard top angle and self-supporting base.

H. Rack side rails shall be pre-drilled and tapped (both front and rear) in accordance with the EIA 19" mounting standard.

I. A grounding kit shall be provided with each rack. The Contractor shall provide one (1) #6 AWG ground wire from each rack to the telecommunications ground bar installed within the room.

J. Horizontal wire management panels shall be provided as indicated on the drawings to ensure a neatly dressed installation.

K. Double-sided vertical wire management troughs shall be provided between free standing racks and on the ends of a row of racks or as indicated on the drawings. The cross-sectional area of the wire management troughs shall be no less than 24 sq. inches.

L. Racks and wire management troughs in a row shall be securely bolted together.

M. Racks shall be securely bolted in place.

N. A three (3) foot clear work space shall be maintained in front and back of each rack and at one end of each row of racks. Where space permits, a space of three (3) feet shall be maintained at both ends of each row of racks.

O. Cable runs to racks which terminate at the rear of patch panels and other devices shall be run at the rear of the double sided vertical wire management trough. Patch cords and other cable runs which terminate on the front of the rack shall be run in the front section of the double sided vertical wire management trough. Cable distribution shall be routed evenly along both rails to the maximum extent possible.

P. Cabling for connection to rack mounted patch panels and equipment shall be dressed such that the labeling of the patch panels and/or equipment is readily visible and access to said items is not obstructed. Where accessories for managing cable at the rear of the patch panel are available, they should be provided whether or not explicitly stated.

Q. Where access to racks is from cable tray or ladder rack mounted above, Kindorf extensions shall be provided from the frame side members to the cable tray or ladder rack for supporting cable runs (where necessary).

R. Each rack shall be labeled as described elsewhere in this specification.

2.7 LADDER RACK

A. Ladder rack shall be made of straight sections, fittings and accessories as defined in the latest NEMA standards publication VE-1 and shall be UL classified as equipment grounding conductors.

B. Ladder rack material shall be steel tubular bar with baked enamel finish.

C. Ladder rack shall be of ladder type and shall consist of cross-members (3/8"H x 1-1/2"W) spaced 9" on center, which are welded to the inside of side rails (1-1/2"H X 3/8"W).

D. Lengths shall be from 4'-5-1/2" to 9'-11", not including connectors, if attached.

E. Widths shall be 12", 18", 24", 30", or 36", as indicated on the drawings.

F. All ladder racks shall be joined at all crossings, intersections, angles, etc. Using approved couplers, brackets and splices manufactured for this purpose. Straight sections shall be fastened together using a matching butt-splice kit.

G. Provide cable spill-outs ("waterfalls") at the location of each vertical wire management trough and wherever cable is routed from the ladder rack to equipment below.

H. Special accessories shall be provided to protect, support, and install a complete ladder rack system.

I. Install the ladder rack so that there is a minimum of 6" clearance above the top of the side rails. Installation shall be such that cables may be laid directly onto the rack in lieu of pulling.

J. Support ladder rack in accordance with all applicable standards and best industry practices.

K. Provide a connection from the ladder rack to the telecommunications ground bar. Install ladder rack so as to ensure ground continuity for the entire assembly. Provide ground straps at all expansion fittings.

2.8 ACCESSORIES

A. J-Hooks

1. Steel; UL Listed; ultimate static load limit 50 lbs., 2" in diameter. Rated to support Category 6 and higher cables and optical fiber cables.

2. If required, assemble manufacturer recommended specialty fasteners including beam clips, flange clips drop wire/rod, C and Z purlin clips and fasteners for access floor support stantions.

2.9 MATERIALS LIST

A. Where the drawings and/or specifications indicate materials to be provided by the Contractor, they shall be provided without substitution. Any conflict with this requirement shall be brought to the Engineer's attention.

B. The parts referred to in this document and/or drawings are recommended types. The vendor supplying these parts must supply the same or equivalent parts. Where acceptable substitutes are available from only one vendor, no substitutions will be permitted. The Owner or his representative reserves the right to examine and approve any and all parts acquired to satisfy the installation requirements and to reject these parts without penalty if they do not meet with the specifications.

C. The items indicated in the Materials List shall not be construed as a "bill of materials". They represent items of significance used during the design of the cabling installation. Where the items indicated are one portion of an assembly, the entire assembly shall be provided unless specified otherwise. Where items do not have a manufacturer or part number listed, no particular item has been selected at this time.

PART 3 – EXECUTION

3.1 IDENTIFICATION AND TAGGING FOR TELECOMMUNICATIONS DEVICES

A. The Contractor shall label individually:

1. Each and every copper cable.

2. Each and every fiber optic cable.

3. Each outlet faceplate/termination box (and each jack/port).

4. Each termination block and patch panel (and each termination).

5. Each equipment and termination frame, rack, and cabinet.

6. Each wall termination field.

7. Each junction box and pull box used for telecommunications cabling.

8. Each system (i.e., voice, LAN, etc.) as identified by the Engineer.

9. Other items as directed.

B. The nomenclature used to identify cables, blocks, equipment, etc. shall be as specified on the drawings or elsewhere in this specification. Missing or unclear nomenclature criteria for the items specified above shall not be construed as a reason not to identify the items and shall be brought to the Engineers attention.

C. All materials required for labeling shall be provided by the Contractor. All labels shall be permanently adhered and easily visible. Printing on all labels shall be permanent and smudge-proof. All text shall be typed or otherwise machine printed. Handwritten labels will not be accepted.

D. Cables shall be identified using wrap around "brady" type labels at both ends minimum.

E. Identification of all equipment frames, racks, cabinets and wall termination fields shall be by means of engraved lamacoid nameplates showing 1" high white lettering on a black background.

F. Identification of all rack or wall mounted equipment, patch panels, etc. shall be by means of engraved lamacoid nameplates showing 1/4" high white lettering on a black background fastened in the upper left hand corner of all equipment. An attempt shall be made to place the label in the same location on similar equipment.

G. For patch panels, each port shall be identified on both the front and rear of the patch panel.

H. Identify each outlet box, junction box, and cabinet used in conjunction with empty raceway for wires of a future system by means of indelible markings on the inside denoting the system.

I. Junction boxes used for telecommunications wiring and located in unfinished spaces (i.e., hung ceilings, equipment rooms, etc.) shall be clearly identified on the outside as "COMM."

3.2 FIRESTOPPING

A. Firestopping shall be provided for all penetrations of conduit, wireways, bus ducts, cable trays, etc., through fire-rated walls and floors and other fire-rated separations as follows:

1. Excess space in framed openings through structural floors between conduits and concrete shall be grouted in with concrete to a depth of at least the thickness of the slab plus 2" minimum above the slab.

2. Conduit penetration through poured concrete or masonry walls shall be grouted in with concrete and provided with tight fitting escutcheon plates on both sides.

3. Conduit penetrations through fire-rated dry walls shall be with sleeves through the wall, fitted with escutcheon plates on both sides with excess openings filled with firestop material specifically manufactured for the purpose.

4. Excess space within conduit sleeves or stubs through floor slabs or walls where low voltage/telecommunications cables pass through shall be filled with firestopping material specifically manufactured for the purpose.

5. Where cable trays pass through fire-rated partitions or floors, utilize fittings specifically manufactured for this purpose that include multi-cable framed opening sleeves through the wall or floor and insert modules of firestop material through which the cable passes--all installed in accordance with manufacturer's recommendations. Include all additional components necessary for a complete firestop installation. The total cross sectional area of the firestop frame shall be equal to four (4) times the cross sectional area of the cable tray. The cable tray shall stop on each side of the wall or floor.

6. Utilize fire-rated fittings, as specified elsewhere, for penetrations through floor slabs for supplying floor outlets.

B. All conduits/sleeves used for vertical cable passage shall be sealed utilizing suitable material after the installation of cables as follows:

1. The material shall be non-corrosive to the cable jacket or insulation that it applies to.

2. The material shall provide for a minimum of a three (3) hour fire rating.

3. The material shall be non-shrinking, waterproof, and smoke tight.

4. The material shall remain flexible and non-hardening.

5. The material shall be of the type that when installed will not slip through the openings, will stick to the surfaces of the openings, and the cabling and will not require any pressure to be applied to the cabling in order to keep it in place.

6. The material shall be installed in a neat and workmanlike manner, and the final installation shall be smooth finished to the top of the sleeve or conduit.

7. The material shall be easily removable without damaging the cables after being set or cured for at least one week.

C. All horizontal cable penetrations through the IT Room walls shall be provided with pre-formed, round firestop devices with integrated intumescent strips for use with noncombustible and combustible pipes (closed and open systems), conduit, and/or cable bundles penetrating concrete floors and/or gypsum walls, the following products is acceptable:

1. Hilti Speed Sleeve (CP 653) for use with cable penetrations.

D. Upon completion of the telecommunications work, the Contractor will certify that all openings for the cables are satisfactorily sealed and fire stopped.

E. All materials used for firestopping shall be approved for the purpose and the rating of the wall or floor, and all methods employed shall meet with the approval of the local authorities.

F. Refer to architectural drawings and specifications for all locations of fire rated walls and floors.

3.3 MOUNTING HEIGHTS

A. Heights of all wall mounted outlets shall be in accordance with the following list (dimensions are above finished floor, unless otherwise noted.)

1. Telecommunications outlet in field constructed wall, partition, or column unless otherwise specified below -- 18" to centerline.

2. Telecommunications outlet in factory fabricated wall or partition, unless otherwise specified below -- dimension determined by wall or partition construction.

3. Telecommunications outlet in telecommunications rooms, mechanical spaces, electric switchboard rooms, electric closets, etc. -- 54" to centerline.

4. 110 type termination blocks wall mounted in SER and IDF locations -- 6'-0" to the top of the highest termination block. The clearance between adjacent 110 type termination blocks shall be 3" minimum.

B. Heights of all wall mounted outlets shall be in accordance with the architectural drawings and details. Equipment mounting heights shall be in accordance with telecommunications details. Any discrepancies shall be brought to the Engineer's attention.

C. Architectural drawings and field instructions issued by the Architect take precedence over the above list and shall be adhered to.

3.4 SUPPORTS

A. Support work in accordance with best industry practices and the following.

B. Include supporting cabinets to floor in all telecommunications rooms.

C. Supporting cables with Kindorf, cable hangers, and threaded rod are the responsibility of the Contractor.

D. Nothing (including pull boxes, junction boxes, and fittings) shall depend on conduits, raceways, or cables for support.

E. Nothing shall rest on, or depend for support on, suspended ceiling media (tiles, lath, plaster, as well as splines, runners, bars, and the like in the plane of the ceiling). Vertical members that suspend the ceiling (together with their horizontal bracing that occurs above the ceiling), however, may be used for support.

F. As a minimum procedure, in suspended ceilings support small runs of circuitry from ceiling suspension members as defined above. Support larger runs of circuitry directly from structural slabs, decks or framing members.

G. Where support members must of necessity penetrate air ducts, include, in accordance with instructions issued in the field, airtight sealing provisions that allow for a relative movement between the support members and the duct walls.

H. Include in the telecommunications work channel sills or skids for leveling and support of all floor mounted telecommunications equipment.

I. Where permitted loading is exceeded by direct application of telecommunications equipment to a slab or deck, include in the telecommunications work proper dunnage as required to distribute the weight in a safe manner.

J. Fire-resistant nylon cable ties shall be used for securing riser cables. The cable ties shall be laced through the strands of the messenger and secured to the cables to be supported.

K. All cable ties used to support telecommunications cabling shall be of a fire-resistant nylon type. The support rating of the cable ties used shall be a minimum of twice that of the weight per unit of the cable(s) to be supported.

L. Riser cabling shall be supported via wall mounted Kindorf framing or vertical ladder rack. The framing shall be extended the entire length of the riser shaft (whether or not used entirely by the communications contractor). Vertical members for cable support shall be extended and secured from slab to slab at distances no more than 4' on center. No less than three (3) horizontal cross members shall be fastened to the vertical members using approved system accessories. All framing components shall be 1-1/2" by 1-1/2" minimum perforated ‘C’ channel.

3.5 FASTENINGS

A. Fasten telecommunications work to the building structure in accordance with best industry practices and the following.

B. As a minimum procedure, where weight applied to the attachment points is 100 pounds or less, fasten to building elements of:

1. Wood -- with wood screws.

2. Concrete except precast and solid masonry -- with bolts and expansion shields.

3. Hollow construction -- with toggle bolts.

4. Solid metal -- with machine screws in tapped holes or with welded studs.

5. Precast concrete and steel decking or subfloor --with fastenings as specified below for applied weights in excess of 100 pounds.

C. No more than three (3) riser cables in excess of 0.5" in diameter shall be fastened using one cable tie.

D. Cable ties shall be deployed every four (4) feet minimum when fastening telecommunications cables in horizontal cable tray.

E. Cable ties shall be deployed every two (2) feet minimum when fastening telecommunications cables run vertically on a wall or rack.

F. Cable ties fastening multiple small cables shall form a grouping no larger than three (3) inches in diameter.

G. Fire-resistant nylon cable ties shall be used for fastening riser cables to vertical cable tray.

H. All cables shall be grouped and bundled utilizing approved nylon cable ties, best industry practices, and the following:

1. Where multiple cables serve a single outlet, the cables shall be tied as a single bundle every four (4) feet, minimum.

2. Horizontal cabling routed in cable tray shall be tied every ten (10) feet, minimum.

3. Cables routed in surface mounted raceways shall be tied and fastened to the raceway using tie anchor mounts secured with screws every two (2) feet, minimum.

4. Cables routed in furniture systems shall be tied at every pedestal location and at least once in between each pair of pedestals, minimum.

5. Cables shall be tied on racks, frame, cabinets, etc., every two (2) feet, minimum.

3.6 LOCATING AND ROUTING CIRCUITRY

A. All circuitry shall be run concealed. Exceptions where cabling shall be run exposed include:

1. Horizontally at the ceiling and vertically on the walls of telecommunications spaces and of permanently unfinished spaces which are not assigned to mechanical or electrical equipment.

B. Concealed circuitry shall be located so that building construction materials can be applied over its thickest elements without being subject to cracking.

C. Circuitry run exposed shall be routed parallel to building walls and column lines.

D. Exposed circuitry located overhead shall be run in a completely accessible manner on the underside of all piping and ductwork.

E. Circuitry run in suspended ceilings shall be routed parallel to building walls, column lines, etc.

F. Circuitry shall be routed so as to prevent telecommunications conductors from being subject to high ambient temperature. Minimum clearances from heated lines or surfaces shall be maintained as follows:

1. Crossing where uninsulated -- 6"

2. Crossing where insulated -- 3"

3. Running parallel where uninsulated -- 3'-0"

4. Running parallel where insulated -- 6"

G. Circuitry shall not be routed over or under a boiler except where special provisions for wiring through these specific high ambient temperature areas have been indicated.

H. Circuitry shall not be run in elevator or dumbwaiter shafts, hoistways, and the like.

I. Circuitry for miscellaneous systems indicated without notation as to location and routing shall be run as per the requirements and notations governing the adjacent telecommunications circuitry.

J. Under no circumstances shall voice/data wiring pass through electrical closets, switchgear rooms, gas meter rooms, mechanical spaces, janitor closets (unless noted), etc.

K. The distance limitations for the following cable types/systems shall be as follows:

Cable Type/System	Max. Distance
23 or 24 AWG Twisted Pair (4 pr.)	90m (295 ft.)

L. Provide a minimum of 6" clearance between telecommunications cables and fluorescent, neon, incandescent, or high intensity discharge fixtures such as mercury vapor lamps.

M. Provide a minimum of 36" clearance between telecommunications cables and all motors, transformers, or other devices with a potentially high electromagnetic interference.

N. The Contractor shall utilize existing empty conduits, provided by others, for the routing of the telecommunications wiring.

O. The Contractor shall utilize existing cable tray, provided by others, for routing of telecommunications wiring.

P. The Contractor shall utilize the raised floor system provided in special rooms (i.e., computer rooms, etc.), where applicable, for the routing of the telecommunications wiring. The routing under the raised floor shall be via "accessible corridors."

3.7 INSTALLING CIRCUITRY

A. In runs of conduit or raceway (including flexible types), limit the number of bends between cable access points to a total which does not exceed the maximum specified for the particular system. Where no such maximum is specified, limit the number to two right angle bends or the equivalent thereof.

B. Each conduit or raceway assigned for telecommunications work shall be provided with a bushed opening.

C. All conduits entering telecommunications rooms and/or equipment rooms shall be provided with bushed openings.

D. It is the Contractor's responsibility to ensure that the telecommunications cabling is protected from all sharp edges, burrs, etc., in all raceway systems intended for telecommunications cabling.

E. At each outlet, the Contractor will cable and install cable connectors for connection to final equipment. The Contractor will cable, connectorize, and/or punch down cables on connector blocks and/or patch panels furnished and installed in the telecommunications rooms serving the various station areas. Riser pre-bundled or bulk cables will be labeled, connectorized, punched down and cross-connected through a separate set of terminal strips and then routed through inter-floor slots or sleeves. Other outlet locations will be cabled as specified and indicated elsewhere.

F. The Contractor is responsible for all pulls through conduits, sleeves, etc. of all bundled or individual cables, including all labelling and connectorizing at all junctions and terminations. All required connecting blocks shall be furnished and installed by the Contractor. Other outlet locations will be cabled and specified as indicated on the drawings.

G. Each type of cabling media (i.e. fiber, twisted pair, etc.) shall be bundled separately for all horizontal runs unless otherwise specified.

H. The Contractor shall be responsible for maintaining the manufacturer's recommended minimum bend radius on all cables throughout the installation.

I. All cables terminated on blocks, patch panels, equipment assemblies, etc., shall be installed in increasing consecutive alphabetical or numerical order, starting from the upper left hand corner of the terminating device, unless otherwise noted.

J. All cables shall be provided with strain relief such that pulling on the cable jacket will not affect the terminated conductors.

3.8 PULLING WIRES INTO CONDUITS AND RACEWAYS

A. Delay pulling all cabling until the project has progressed to a point when general construction procedures are not liable to injure wires and cables and when moisture is excluded from raceways.

B. Utilize nylon snakes or metallic fish tapes with ball type heads to set up for pulling.

C. In raceways of 2" trade size and larger, utilize a pulling assembly ahead of wires consisting of a suitable brush followed by an 85% diameter ball mandrel. Submit certifications that mandrelling has been performed as specified.

D. Prior to installation, submit evidence that wires are new (in accordance with the definition of "new" as hereinbefore specified).

E. Leave sufficient slack on all runs of wire and cable to permit the secure connection of devices and equipment.

F. Pulling lubricants shall be products manufactured specifically for the purpose.

G. Slack on wires and cables located in cabinets and pull boxes shall be formed and set in place in groupings corresponding to their occupancy of raceways. They shall also be arranged, with insulators and supports provided where necessary, such that cable shims or other such temporary expedients do not have to be left permanently in place to prevent the wires and cable from shifting when covers or trims are removed.

3.9 GROUNDING AND BONDING

A. Ground all systems and equipment in accordance with best industry practices and the following:

1. All ground connectors in the main equipment room and telecommunications rooms shall be made to the ground bars provided for that purpose as part of the electrical work.

2. All metal panels, enclosures, boxes, racks, raceways, etc. in equipment rooms, telecommunications equipment rooms and closets shall be grounded.

3. Conductors utilized for grounding and bonding shall not be less than #6 AWG and shall have type "TW" or better insulation. Cables used for grounding and bonding shall have green jacket color.

3.10 TESTING

A. Before an application for final acceptance of the telecommunications work will be considered, all tests deemed necessary by the Owner and Engineer to show proper execution of the telecommunications work shall have been performed and completed in the presence of the Owner's representative. Scheduling of all testing procedures shall be arranged to suit the convenience of the Owner.

B. Tests specified to be performed in this document are intended to verify the quality of all cabling. This document also establishes a uniform method of reporting the test results for evaluation by the Engineer and Owner.

C. All tests are to be performed upon completion of the initial installation.

D. Performing the indicated tests does not constitute equipment or circuit acceptance.

3.11 TEST EQUIPMENT

A. The equipment indicated below represents test equipment utilized to develop this test specification. Substitute test equipment may be used provided the same level and quality of testing is performed.

B. Prior to any testing being performed, the Engineer shall be supplied with a list of test equipment to be used, for his review and approval, if not the equipment identified in this specification. The submittal shall include documentation indicating that the proposed equipment is capable of performing all of the tests as required by this specification.

3.12 TESTS TO BE PERFORMED

A. Tests are to be performed on the following aspects of the telecommunications cabling system:

1. From each telecommunications room (IDF) termination to each and every outlet termination.

2. From each main equipment room (MDF) termination block to each corresponding telecommunications room (IDF) termination

B. All cable runs for which equipment will not initially be attached must be tested to the same level of compliance as all other cabling.

C. Prior to any acceptance testing being performed, a sample test shall be performed for each series of tests (i.e., copper, fiber, etc.). The sample test shall consist of a regular acceptance test on a few sample cables as selected by the Contractor.

D. Voice grade cable

1. Test equipment -- Fluke DTX 1800 Series (Level 4) Tester or newer and all applicable accessories.

2. Tests to be performed

a. The following items must be demonstrated:

(1) Conductors are electrically continuous between terminations.

(2) Conductors are electrically isolated from all other conductors.

(3) Conductors contain no shorts to ground.

(4) Cables have a properly grounded shield (where applicable) as specified and in accordance with the best industry practice.

(5) Polarity.

E. Data grade cable - The tests on this cable shall be the same as for Item D above. In addition, the following test shall be performed on all pairs of a twisted pair cable or pair #1 of a cable greater than 4 pairs.

1. Test equipment -- Fluke DTX 1800 Series (Level 4) Tester or newer and all applicable accessories.

2. Tests to be performed

   a. The test equipment shall be configured to test the maximum transmission performance for which the cable is rated (i.e., Cat 3 = 10 Mbps, Cat 6 = 1000 Mbps).

   b. The following minimum information shall be provided for each cable and pair to be tested:

      (1) Length - find the total cable length.

      (2) Resistance - measured for each cable pair.

      (3) Noise - measured for each pair at the following frequencies: 10Hz - 150KHz, 150KHz - 16MHz, 16MHz - 100MHz

      (4) Insertion Loss (Attenuation) - measured for each pair at 10MHz.

      (5) Near End Cross Talk (NEXT) - measure NEXT in dB and the associated frequency.

      (6) Delay - measured for each pair.

      (7) Delay Skew - find the delay skew between the fastest and slowest pairs.

      (8) Attenuation to Crosstalk Ratio (ACR).

      (9) Power Sum Near End Crosstalk (PSNEXT)

      (10) Wire map - indicate that the wiring at the near end and far end are as specified.

   c. For all cables required to meet Category 6 requirements detailed elsewhere in this specification, the following additional information shall be provided for each cable and pair:

      (1) Equal Level Far End Crosstalk (ELFEXT)

      (2) Power Sum Equal Level Far End Crosstalk (PSELFEXT)

      (3) Power Sum Attenuation to Crosstalk Ratio (PSACR)

      (4) Structural Return Loss (SRL)

   d. During testing (link test), if any failures or marginal pass results occur (a marginal pass is indicated as "*pass" on the test equipment), the following procedures are to be taken:

(1) For marginal pass (*pass) results, the circuit will be retested. If the re-test result is a failure, troubleshoot and correct the problem. If the result is again a marginal pass for any reason other than excess length, troubleshoot and correct the problem as if the result were a failure. If the marginal pass is due to excess length, make every effort to remove slack in the run and re-test.

(2) For failure results, re-test and/or troubleshoot to correct the problem. Provide documentation to support the good circuit by providing the test results of that circuit that indicate "pass" (a non-marginal pass).

(3) Provide an explanation for each failure for each marginal pass result that has not been resolved, including a description of the steps taken to troubleshoot the circuit and the reason why further corrective action has not been undertaken.

3. Fiber optic cable

a. Test equipment -- Optical time domain reflectometer (OTDR) with chart recorder.

4. Tests to be performed

a. A prequalified one hundred (100) foot minimum fiber optic cable containing the same performance parameters of the cable to be tested, shall be connected at the OTDR end of the test setup.

b. The OTDR shall be used on each fiber optic strand to identify the following parameters. The below measurements shall be taken at both 850nm and 1300nm using a short pulse width:

(1) Length of cable.

(2) Discontinuities with the cable/connectors.

(3) Areas of localized attenuation.

(4) Total loss (dB) from end to end including terminations.

c. Cursor and marker distances shall be standardized for fiber optic cables with the same origin and destination for all tests (i.e., main equipment room to telecommunications room).

d. No area of localized attenuation shall be greater than 0.2 dB.

e. The OTDR trace should be expanded to fill at least two-thirds to three quarters of the OTDR screen. The input pulse and the end "spike" of the cable shall both be displayed.

f. The input pulse and the end "spike" shall be elevated off the bottom of the screen by approximately one division.

g. Each OTDR trace shall be annotated with information regarding fiber identification and the settings selected on the OTDR.

h. The OTDR traces shall be maintained as a permanent record for the purposes of maintenance and restoration.

F. Coaxial cable (if applicable)

1. Test equipment - Fluke DTX 1800 Coaxial Tester or newer, or equal

2. Tests to be performed

a. The following items must be demonstrated:

(1) Conductors are electrically continuous between terminations.

(2) Conductors are electrically isolated from all other conductors.

(3) Conductors contain no shorts to ground.

(4) Cables have a properly grounded shield (where applicable) as specified and in accordance with best industry practices.

3. The Cabling Contractor shall perform continuity testing upon installation and termination or all infrastructure cabling and provide a cable run sheet indicating the results. Further tests may be requested by consultant if continuity results are deemed unsatisfactory. Any cable which is determined to not meet performance specifications following continuity testing shall be replaced at no further cost to the owner before the system shall be accepted as complete. Continuity test results may not be used to qualify cabling performance specifications or acceptance.

4. Testing and Certification of installed and terminated vertical and horizontal cables for Structural Return Loss are based on FCC standard methods of determining SRL. The installed cable infrastructure shall meet or exceed the cable manufacturer's specifications for SRL.

5. A copy of the test results in both electronic and printed formats shall be provided to the Engineer for his review and the Owner for his records.

3.13 CORRECTIVE ACTION

A. Any defects or deficiencies discovered in any of the telecommunications work shall be indicated on the test report and be corrected.

B. Upon completion of testing and problem resolution, all connections tested are to be 100% error free.

C. Any connections determined to be not correctable shall be indicated at each end of the termination as "bad" (in red).

3.14 EQUIPMENT INSTALLATION AND TESTING

A. The Contractor shall be available during equipment installation and testing to help isolate faults that may exist in the cabling system installation.

B. The Contractor shall coordinate with other vendors where necessary to resolve any discrepancies between the cabling system and the vendors' cabling or equipment.

END OF SECTION 27 00 00

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SECTION 27 41 00 - AUDIO-VIDEO COMMUNICATIONS

PART 1 - GENERAL

1.1 REFERENCE TO GENERAL CONDITIONS:

A. The General Conditions shall be considered as forming a part of the audiovisual specifications and shall be carefully examined before proposals for any work are submitted. Unless the specifications contain statements which are more definitive or more restrictive than those contained in the General Conditions, the specifications shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions.

B. Refer to the Specification Section for Electrical. The electrical requirement for audiovisual systems shall be installed in accordance with this specification.

1.2 AV PROJECT OVERVIEW:

A. The selected AV Contractor shall provide turnkey engineering, fabrication, AV-related low voltage cabling and terminations, installation, training, documentation, and one year of warranty coverage for hardware, software, and workmanship in the spaces and subsystems in scope. The AV Contractor shall provide fully operational systems based on the AV Written Specification, AV Drawings, AV equipment list, and Architectural drawings, whether or not every required interface and component is specifically detailed therein. Any questions about the system designs or required additional components shall be submitted in written form prior to submittal of the bid response. It shall be assumed that by responding to the AV Contractor portion of the bid with no specific questions or additions, that you have thoroughly reviewed all elements of the bid documents, and that you understand the intent of the design and that you shall provide a fully operational system solution at no further cost to Tenant, unless specifically stipulated in your bid response. The Bid responses shall be submitted using the Excel Bid Response Form File. The bidder shall not insert rows or columns or deviate in any way from the provided Excel Bid Response Form. Any additional information deemed appropriate for clarification shall be provided as an addendum to the Excel Bid Response Form File.

B. The AV Contractor shall provide the all specified hardware elements and all required jumper cables to create completely operational systems. Any hardware not listed on the bid response form that the contractor feels is required in order to have a fully operational system should be included in the alternate price quotation sheet of the Bid Response Form. If no equipment is listed on the alternates page, it is assumed that the price given by the contractor for every room shall include all installation, mounting and cabling accessories required including any needed power strips or rack mounting accessories.

1.3 AV CONTRACTOR SCOPE OF WORK:

A. All Audiovisual work shown in the AV drawings and this AV Specification shall be included under the Audiovisual base bid, except where there is specific reference to exclusion and incorporation in other quotations. In addition to the Base Bid depicted on the drawings, Bid Response Form, and this Written Specification, the Scope of Work shall also include the clarifications and requirements as indicated in the Appendices attached at the end of this Specification. These appendices shall include, but shall not be limited to:

1. Appendix A: List of test to be perfomed by the AV Contractor

2. Appendix B: AV Bid Reponse Form, Bidders must use Excel file to return the bids.

B. The AV Bidder, by returning the *Bid Response Form* found in this AV Specification, unless otherwise noted by the Bidder, is assumed to have read, understood, and agreed to the complete requirements delineated in the AV Specification, AV Drawings, and associated Project Documents.

C. The AV Contractor shall provide and install the elements as shown on audio/visual drawings included under separate cover

D. Include in the audiovisual work all necessary supervision and the issuing of all coordination information to any other trades who are supplying work to accommodate the audiovisual installations.

E. For items of equipment, if any, which are to be installed but not purchased as part of the audiovisual work (i.e., Tenant Supplied Equipment), the audiovisual work shall include:

1. The coordination of their delivery.

2. Their unloading from delivery trucks driven in to any point on the property line at grade level.

3. Their safe handling and field storage up to the time of permanent placement in the project.

4. The correction of any damage, defacement or corrosion to which they may have been subjected.

5. Their field make-up as may be necessary for their proper operation.

6. Included shall be the purchase and installation of any adapters or other wiring terminations as may be necessary to adapt their terminals to the wiring as called for and to the connection methods set forth in these specifications.

7. The AV Contractor shall provide and install all power strips required in racks, under tables, in credenzas, and in all other locations where AV equipment is be plugged in and where the available power jackplate does not have sufficient outlet quantity. The cost for power strips should be included in the miscellaneous section for each room type, which should be added to your total cost and should cover all of the cost of the miscellaneous power strips. The contractor shall be required to determine the size of the required power strips for each specific location and condition.

F. Items of equipment, if any, which are to be installed but not purchased as part of the audiovisual work shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the audiovisual work will be considered only if presented in writing within one week of the date of delivery to the project of the items in question. The audiovisual work includes all procedures, regardless of how extensive, necessary to put into satisfactory operation, all items for which no claims have been submitted as outlined above.

1.4 CODES, PERMITS AND INSPECTIONS:

A. All audiovisual work shall meet or exceed the latest requirements of all national, state, county, municipal, and other authorities exercising jurisdiction over the audiovisual work and the project.

B. Any portion of the audiovisual work which is not subject to the requirements of an electric code published by a specific authority having jurisdiction shall be governed by the National Electrical Code and other applicable sections of the National Fire Code, as published by the National Fire Protection Association.

C. Installation procedures, methods and conditions shall comply with the latest requirements of the Federal Occupational Safety and Health Administration (OSHA) and the Americans with Disabilities Act (ADA).

1.6 GUARANTEES AND CERTIFICATIONS:

A. All audiovisual work shall be guaranteed to be free from defects. Any defective materials or workmanship, as well as damage to the audiovisual work resulting from the work of all trades, shall be replaced or repaired as directed for the duration of stipulated guarantee periods.

B. The duration of guarantee periods following the date of acceptance of the audiovisual work shall be:

1. For work not otherwise specified -- one year. This includes one year warranty coverage by the AV Contractor if specific furnished products carry less than one year warranty by the manufacturer.

2. For products having greater than one year warranty coverage by the manufacturer, the AV Contractor shall not be bound by the duration for warranty coverage of those devices pass First Year Warranty Period.

C. When available, all components shall be coordinated and installed as part of a manufacturer's certification program. Where components selected are from different manufacturers and are not covered as part of a single (or multiple) program(s), the AV Contractor shall guarantee all aspects of the audiovisual installation as outlined in this specification and associated drawings for the above stipulated minimum period. The starting point of the guarantee period shall be extended indefinitely as long as the AV Contractor continues to provide services and maintenance on systems outlined in this specification, prior to formal system “acceptance” by the Tenant.

D. The date of acceptance shall be the date of the final payment for the audiovisual work or the date of a formal notice of acceptance, whichever is earlier (except as noted above).

E. Non-durable items shall be replaced up to the date of acceptance, such that they shall have had no more than 10 hours use prior to this date.

F. Prior to Acceptance, certification shall be submitted attesting to the fact that specified performance and other criteria are met by all items of audiovisual work where a particular level of performance is indicated.

G. All Manufacturers' equipment warranties shall be activated by the AV Contractor in the Tenant's name and shall commence on the date of system acceptance. In the case of AV Contractor-modified equipment, the manufacturer's warranty is normally voided. In such cases, the AV Contractor shall provide the Tenant with a written warranty equivalent to that of the original manufacturer.

1.7 DEFINITIONS AND INTERPRETATIONS:

A. As used in the drawings and specifications for audiovisual work, certain non-technical words shall be understood to have specific meanings as follows regardless of indications to the contrary in the General Conditions or other documents governing the audiovisual work.

1. "Furnish" -- Purchase and deliver to the project site complete with every necessary appurtenance and support, all as part of the audiovisual work. Purchasing shall include payment of all sales taxes and other surcharges as may be required to assure that purchased items are free of all liens, claims or encumbrances.

2. "Install" -- Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project, all as part of the audiovisual work.

3. "Provide" -- "Furnish" and "install."

4. "New" -- Manufactured within the past year and never before used.

B. In the drawings and specifications, certain words or abbreviations are used in a particular context. They are the following:

WORDS/ABBREVIATIONS	MEANING
Engineer; Consultant	AV Consultant
Bidder	Potential AV Contractor responding to AV Specification
Contractor	General Contractor and/or Audiovisual (AV) Contractor (also referred to as AV Integrator)
EC	Electrical Contractor
By Others	Work performed by others but coordinated with the AV Contractor

C. Regardless of their usage in codes or other industry standards, certain words as used in the drawings or specifications for the audiovisual work, shall be understood to have the specific meanings ascribed to them in the Audiovisual Specification drawings and documents of this project. The understanding of such terms by the AV Contractor shall be derived from these documents.

D. Reference to "U.L. (Materials Construction) Standards" shall mean the "Standards for Safety," published by Underwriters Laboratories, Inc. (Main Office: 333 Pfingsten Road, Northbrook, Illinois 60062).

E. Reference to "NEMA Standards" shall mean the "Approved Standards" published by the National Electrical Manufacturers Association (Main Office: 2101 "L" Street, N.W., Washington, D.C. 20037).

F. Reference to "ANSI Standards" shall mean the standards published by the American National Standards Institute (Main Office: Twenty East Fortieth Street, New York, New York 10016).

G. Reference to "EIA/TIA Standards" shall mean the standards published by the Electronic Industries Association and Audiovisual Industry Association, 201 Pennsylvania Avenue, N.W., Washington, D.C. 20006.

H. Reference to "IEEE Standards" shall mean the standards published by the Institute of Electrical and Electronics Engineers.

I. Reference to “SMPTE Standards” shall mean standards published by the Society of Motion Picture and Television Engineers, 595 West Hartsdale Ave, White Plains, NY 10607.

J. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any audiovisual item in the drawings and specifications for audiovisual work carries with it the instruction to furnish, install and connect the item as part of the audiovisual work regardless of whether or not this instruction is explicitly stated.

K. It shall be understood that the AV Specifications and AV Drawings are complementary and are to be taken together for a complete interpretation of the audiovisual work. Where there are conflicts between the drawings and specifications or within the specifications or drawings themselves, the items of higher standard shall govern. Discrepancies must be brought to the attention of the Architect by the AVContractor.

L. To the extent that they govern the basic work, the specifications also govern change order work, if any.

M. No exclusion from or limitation in, the symbolism used on the drawings for audiovisual work or the language used in the specifications for audiovisual work shall be interpreted as a reason for omitting the appurtenances or accessories necessary to complete any required system or item of equipment.

N. The drawings for audiovisual work utilize some symbols and schematic diagrams which have no dimensional significance. The audiovisual work shall, therefore, be installed to fulfill the diagrammatic intent expressed on the audiovisual drawings, but in conformity with the dimensions indicated on the Architect’s Construction Drawings.

O. Certain details appear on the drawings for audiovisual work which are specific with regard to the dimensioning and positioning of the audiovisual work. These are intended only for general information purposes. They do not release the AV Contractor from the requirement for field coordination for individual items of the indicated work with associated trades and field conditions and actual field dimensions.

P. Information as to general construction and architectural features and finishes shall be derived from structural and architectural drawings and specifications. Exact locations for all Audiovisual Jack plates and built-in devices shall be derived from the Architect's Construction Drawings.

Q. The use of words in the singular shall not be considered as limiting where other indications denote that more than one item is referred to.

R. Ratings of devices, materials and equipment specified without reference to specific performance criteria shall be understood to be nominal or nameplate ratings established by means of industry standard procedures.

S. It is the intent of the drawings and specifications to provide a complete operating audiovisual system. All audiovisual work necessary to provide such a system shall be performed. Any discrepancies shall be brought to the Architect's attention.

1.8 SEPARATION OF WORK BETWEEN TRADES:

A. The AV Contractor shall provide all Specified AV Devices, cables, connectors, jackplates, control system, racks, etc.

B. The AV Contractor shall coordinate with the Electrical Contractor to perform certain work as delineated in the Overview section of this Specification.

C. The Electrical Contract, under separate contract, shall provide and install the empty AV conduits, empty junction boxes, and 120 volt power for AV.

D. The IT contractor shall provide the LAN jacks, IPTV jacks, voice, and data outlets

E. The General Contractor shall provide overall project management and the AV Contractor shall conform to all site rules, regulations, and conditions as set forth by the General Contractor

1.9 RECORD DRAWINGS AND DOCUMENTS AND SOFTWARE:

A. As part of the required audiovisual work, a complete set of "as-built" audiovisual drawings shall be made up and delivered to the Owner.

B. The drawings shall show:

1. All audiovisual work installed exactly in accordance with the original design.

2. All audiovisual work installed as a modification or addition to the original design.

3. The dimensional information necessary to delineate the exact location of all circuitry and wiring runs which are so buried or concealed as to be untraceable by inspection through the regular means of access established for inspection and maintenance.

4. The numbering information for all communications raceways, junction boxes, etc. shall be performed in accordance with EIA/TIA 606 standards. All identification numbers shall be reviewed by the Architect and AV Consultant prior to implementation.

5. The numbering information necessary to correlate all audiovisual items (or Jack plates for same) to the end user or head end device to which they are connected.

C. The as-built drawings shall be produced using a CAD design package.

D. The quantity of design drawings which are made available shall in no way be interpreted as setting a limit to the number of drawings necessary to show the required "as-built" information.

E. Any and all costs for document conversion (if necessary), printing, etc., are the responsibility of the AV Contractor.

F. Prior to developing any "as-built" drawings, the AV Contractor shall coordinate with the Tenant, Architect and AV Consultant regarding the layering structure, colors, etc., of all CAD drawings.

G. "As-built" information submitted to the AV Consultant for approval shall contain the following:

1. CAD drawing files on permanent digital media in a format to be determined by the Architect and Tenant.

H. In addition to drawing information, the AV Contractor shall provide three (3) 3-ring bound copies of cable-number information, dated to indicate the latest revision. This shall include a copy of the Electrical Contractor's AV field cable schedule, as well as all in-rack cabling and other cables associated with the AV systems. Any modifications to Architect/AV Consultant supplied cable-number information shall be clearly indicated.

I. The AV Contractor shall establish cable records during the installation. Cable records will be maintained on an automated software program. Fields will be established for recording of active and inactive wires and fibers and riser cables to be updated by the Tenant's personnel at a later date. These records shall correlate the AV device ID number, distribution cable number, conduit or duct path and jack plate location. These records shall be updated as the project progresses to reflect any required changes made either in the field or as a result of design changes. As-built Records/Drawings will be furnished by the AV Contractor as specified after the completion of installation and acceptance of the space by the Tenant, Architect and AV Consultant.

J. The database format (i.e., field and record descriptions) shall be submitted to the Architect and AV Consultant for approval prior to beginning work. A runtime copy of the program to generate fields, manipulate data, produce reports, etc. shall also be provided to the Tenant, Architect and AV Consultant along with the data.

K. The AV Contractor shall provide system drawings which include pin configurations, cable runs, terminal blocks, bulkheads, Jack plates, lecterns, conduit, systems/materials, riser diagrams and workstations or other terminations. The AV Contractor shall keep all documentation current throughout the installation and build-out process. If changes occur which affect any documentation, the AV Contractor shall formally re-issue the affected documentation to the Architect. All "built-out" documentation shall be furnished to the Owner and Tenant at the completion of the installation.

L. All manufacturer's product data including specifications and installation instructions will be provided to the Owner and Tenant upon acceptance of the space by the Owner, Tenant, Architect and AV Consultant. All documents are to be bound in spiral-type or loose-leaf book(s) format.

M. The AV Contractor shall submit a copy of the entire control system program with program code and touchpanel code to the Tenant (where applicable). The means of transmission shall be electronically per instructions from the architect.

1.10 QUALITY ASSURANCE:

A. All equipment and materials for permanent installation shall be the products of recognized manufacturers and shall be new. The AV Contractor shall supply the latest model (in the specified series), available at the time of bidding, of each piece of equipment. If a newer version of selected equipment or software becomes available within (30) thirty days of the issuance of a purchase order by Owner or if a new technology becomes available that offers an alternative to selected equipment or software, the AV Contractor shall offer to substitute such new equipment or software for selected equipment and software. The Tenant shall decide whether or not such substitutions are appropriate, and prices shall be adjusted to reflect increased or decreased costs to the Tenant. The costs of any changes to infrastructure cabling and physical plant design due to new equipment software or technology will be included in the cost revision presented to the Tenant prior to acceptance.

B. New equipment and materials shall:

1. Be Underwriters Laboratories, Inc. (U.L.) labeled and/or listed where specifically called for, or where normally subject to such U.L. labeling and/or listing services.

2. Be clearly labeled identifying the power parameters specified.

3. Be without blemish or defect.

4. Be in accordance with the latest applicable standards.

C. All items of equipment or material of one generic type shall be the product of one manufacturer throughout.

D. It is the intent of these specifications that wherever a manufacturer of a product is specified, and the terms "other approved" or "or approved equal" or "equal" are used, the substituted item must conform with in all respects or exceed the specified item. Consideration will not be given to claims that the substituted item meets the performance requirements with lesser construction or functionality. Performance as delineated in schedules and in the specifications shall be interpreted as minimum performance requirements.

E. Substituted equipment or optional equipment where permitted and approved, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether approved or not, shall be replaced at the AV Contractor's expense. Any modifications of related systems as a result of substitutions shall be made at the AV Contractor's expense.

F. Note that the approval of shop drawings, or other information submitted in accordance with the requirements herein specified, does not assure that the AV Consultant, Architect, or Owner, attests to the dimensional accuracy, dimensional suitability, the ability of the material or equipment involved or the mechanical performance of the equipment. Approval of Shop Drawings does not invalidate the plans and specifications if in conflict, unless a letter requesting such change is submitted and approved on the Architect’s letterhead.

G. Substitutions of Audiovisual Equipment for that shown on the schedules or designated by model number in the specifications may not be considered if the item is not a regular cataloged item shown in the current catalog of the manufacturer.

H. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

I. The AV Contractor shall provide engineering and installation personnel who are factory trained and certified in the major system elements which comprise the AV systems. As an addendum to the bid submittal, the bidder shall submit the names and technical certifications of all shop technicians and on-site installation personnel who will be assigned to the project.

1. For multiple Biamp platforms used on projects:

    a. If this project will utilize Audio Digital Signal Processing (DSP) products by Biamp Systems,the Integrator/Contractor(s)' Systems Engineer(s)/Programmer(s) shall have completed formal training and hold current Biamp Tesira (SERVER line-up), TesiraFORTÉ, Vocia, and/or Audia certifications (relevant to the platform(s) being considered for the project). The bidding integrator/contractor(s) shall submit the name of the trained/certified Systems Engineer/Programmer, along with a copy of his/her certificate, for verification purposes with the manufacturer. It will be expected that the person, for which their certification credentials are submitted, will be doing the programming as per the policies of Biamp Systems. Should the integrator/contractor(s) plan and/or expect to change the programmer and/or use multiple programmers, on this project; then, multiple names and certificates shall be submitted as part of the bid package. As per Biamp Systems' policy, they will not tolerate programming of said certified products by non-trained/non-certified programmers.

2. For projects specifically using Biamp TesiraFORTÉ:

    a. This project will utilize Audio Digital Signal Processing (DSP) products by Biamp Systems. The Integrator/Contractor(s)' Systems Engineer(s)/Programmer(s) shall have completed formal training and hold a current Biamp TesiraFORTÉ certification. The bidding integrator/contractor(s) shall submit the name of the trained/certified Systems Engineer/Programmer, along with a copy of his/her certificate, for verification purposes with the manufacturer. It will be expected that the person, for which their certification credentials are submitted, will be doing the programming as per the policies of Biamp Systems. Should the integrator/contractor(s) plan and/or expect to change the programmer and/or use multiple programmers, on this project; then, multiple names and certificates shall be submitted as part of the bid package. As per Biamp Systems' policy, they will not tolerate programming of said certified product by non-trained/non-certified programmers.

3. For projects specifically using Biamp Tesira SERVER/SERVER-IOs (or combination of SERVER/SERVER-IOs and TesiraFORTÉ:

a. This project will utilize Audio Digital Signal Processing (DSP) products by Biamp Systems. The Integrator/Contractor(s)' Systems Engineer(s)/Programmer(s) shall have completed formal training and hold a current Biamp Tesira certification. The bidding integrator/contractor(s) shall submit the name of the trained/certified Systems Engineer/Programmer, along with a copy of his/her certificate, for verification purposes with the manufacturer. It will be expected that the person, for which their certification credentials are submitted, will be doing the programming as per the policies of Biamp Systems. Should the integrator/contractor(s) plan and/or expect to change the programmer and/or use multiple programmers, on this project; then, multiple names and certificates shall be submitted as part of the bid package. As per Biamp Systems' policy, they will not tolerate programming of said certified product by non-trained/non-certified programmers.

4. For projects specifically using Biamp Vocia:

a. This project will utilize advanced building/campus-wide paging solutions by Biamp Systems. The Integrator/Contractor(s)' Systems Engineer(s)/Programmer(s) shall have completed formal training and hold a current Biamp Vocia certification. The bidding integrator/contractor(s) shall submit the name of the trained/certified Systems Engineer/Programmer, along with a copy of his/her certificate, for verification purposes with the manufacturer. It will be expected that the person, for which their certification credentials are submitted, will be doing the programming as per the policies of Biamp Systems. Should the integrator/contractor(s) plan and/or expect to change the programmer and/or use multiple programmers, on this project; then, multiple names and certificates shall be submitted as part of the bid package. As per Biamp Systems' policy, they will not tolerate programming of said certified product by non-trained/non-certified programmers.

1.11 SUBMITTALS and RESPONSIBILITIES OF THE AV CONTRACTOR:

A. Prior to purchasing any equipment or materials other than the equipment specified herein, a list of their manufacturers and the cut sheets shall be submitted for review.

B. The AV Contractor shall furnish the following unless otherwise noted in drawings or equipment list:

1. Flat Panel Displays

2. Video Projectors

3. Control System Processors

4. Touchpanels

5. Transmitters and Receivers

6. Misc. AV components necessary for fully functional AV system

C. Prior to assembling or installing the audiovisual work, the following shall be submitted for review:

1. Catalog information, factory assembly drawings and field installation drawings as required for a complete explanation and description of all items of equipment.

2. Submit for approval one sample of each of the following:

a. Each type of cable if other than that specified.

b. Each type of cable connector if other than that specified.

c. Each type of jack plate or floor box assembly, complete with labeling, or a full-scale rendering thereof, complete with font-styles and color schemes.

d. Each type of patching/cross connecting device, if other than that specified.

e. Each type of identification label.

f. Other items as requested.

g. Pin-to-pin wiring drawings including all field wire pulls and wiring internal to the equipment rack.

h. Rack elevation drawings, front and back

i. Equipment cabinet shelf arrangements

j. Mounting details

k. Connector plate layouts

l. Shop drawings for rack system integration

m. Exact locations for all permanently installed devices

D. Grille style and color of ceiling speakers or grille cloth, connector plate style and finish, wood grain, stain and finish and any other interior furnishings must have prior approval of the Architect.

E. Documents will not be accepted for review unless:

1. They include complete information pertaining to appurtenances and accessories.

2. They are submitted as a package where they pertain to related items.

3. They are properly marked with the specific system for which they are intended, function, and intended location of use within the project.

4. They are clearly identified or highlighted to indicate all items which are applicable.

5. They indicate the project name and address along with the Contractor's name, address, phone number and contact.

F. Shop Drawing Review by Architect and AV Consultant

1. The purpose of the review of shop drawings is to maintain the integrity of the design. Unless the AV Contractor clearly points out changes, substitutions, deletions or any other differences between the submission and the Contract Documents in writing on the Contractor's letterhead, approval by the AV Consultant or Architect does not constitute acceptance. Except for the products specified herein, it is not to be assumed that the AV Consultant has read the text nor reviewed the technical data of a manufactured item proposed by the AV Contractor, except where the AV Contractor has pointed out differences between his product and the specified model.

2. Shop drawings should consist of the following:

   a. Pin to pin system flow diagrams

   b. Rack elevations – front and rear

   c. Cable management methods for rack cabling

   d. Cable pull schedules

   e. Cable labeling methodology

   f. Mounting details for any equipment mounted on walls/ceilings including but not limited to projectors, speakers, flat panels, and projection screens. Mounting details are to include specific drawings and model numbers of all parts and pieces involved to attach the equipment to the building structure.

   g. Faceplate drawings including custom faceplates within floorboxes or wallboxes

3. It is the responsibility of the AV Contractor to confirm all dimensions, quantities, and the coordination of materials and products supplied by him with other trades. Approval of shop drawings containing errors does not relieve the AV Contractor from making corrections at his expense.

4. Substitutions of equipment, systems, materials, must be coordinated by the AV Contractor with his own or other trades which may be involved with the item, such as, but not limited to, equipment substitutions which change audiovisual or electrical requirements, hanging or support weights or dimensions.

5. Any extra charges or credits which may be generated by other trades due to substitutions will not be accepted unless the AV Contractor has an agreement in writing with the Owner.

6. Substitutions are subject to approval or disapproval by the AV Consultant. The AV Contractor in offering substitutions shall hold the Owner, Tenant and AV Consultant harmless if the substituted item is an infringement of patent held by the specified item.

G. Explanation of Shop Drawing Stamp

1. No Exception Taken indicates that we reviewed the submittal and have not found any reason why this item should not be acceptable within the intent of the documents.

2. Exception Taken as Noted indicates that we have found questionable components which if corrected or otherwise explained make the product acceptable.

3. Revise and Resubmit indicates that this item should be resubmitted for approval before further processing.

a. If both "Exception Taken as Noted" and "Revise and Resubmit" are checked, the resubmittal is for record purposes only.

4. Incomplete-Resbumit indicates that the item will not meet the intent of the Contract.

5. No shop drawing stamp or note shall constitute an order to fabricate or ship. Such notification can only be performed by the Contractor scheduling his own work, or the Owner.

H. Include in the audiovisual work the issuing of operating instructions for the following specialized equipment:

1. All electronic equipment provided or installed as part of the audiovisual work.

2. All database software and/or programs.

I. The issuing of operating instructions shall consist of supplying qualified personnel to demonstrate the operation of specialized equipment. This demonstration shall be performed after the system is installed in the environment, and with external building systems, such as HVAC, on and operating at normal levels. The issuing of operating instructions shall also consist of supplying of all original operating and maintenance instruction manuals.

J. The issuing of operating instructions shall include the submission of the name, address and telephone number of the manufacturer's representative and service company for each item of equipment so that service and spare parts can be readily obtained, at the Owner’s option.

K. After all final tests and adjustments have been completed, the AV Contractor shall fully instruct the Owner and Tenant in all details of operation for the systems installed. Supply qualified personnel to support system operation for a sufficient length of time to assure that Owner and Tenant are properly qualified to take over operation and maintenance procedures. Supply qualified personnel to oversee the installation for sufficient length of time as required to assist all systems equipment vendors in the operation and performance of systems tests.

L. Furnish complete documentation, in bound form containing data covering capacities, maintenance and operation of the installed systems and apparatuses. Operating instructions shall cover all phases of control and include the following:

1. Performance Criteria: For transmission and other criteria as requested.

2. List of Spares: Recommended for normal service requirements.

3. Parts List: Identifying the various parts of the installation for repair and replacement purposes.

4. Instruction Books may be standard booklets but shall be clearly marked to indicate applicable equipment.

5. Wiring Diagrams: Generalized diagrams are not acceptable; submittal shall be specifically prepared for this Project.

M. Where applicable, one set of riser diagrams and/or floor plans, and system flow diagrams shall be neatly framed behind plexiglass and hung adjacent to the racks concerned.

N. All drawings referred to herein are furnished with and become an integral part of this written specification. These drawings and specifications shall remain the property of the Tenant and shall be returned to the Tenant by all unsuccessful Bidders. The Bidder is responsible to examine project documents and drawings which may impact upon the AV installation.

O. Submissions of Lump Sum Bid and Bid Response Form:

1. A lump sum total bid based on the following

2. Equipment costs, on a unit and extended total basis, as formatted in the appended Bid Response Form. The AV Contractor shall provide equipment pricing based on best pricing available.

3. Non-Equipment Costs, including project management/engineering, drafting, in shop assembly and wiring, field installations, training, general and overhead, taxes, etc.

4. Audiovisual Systems Grand Total price should be inclusive of all items and equipment needed to comprise a fully installed, and operational AV system for all system types and quantities listed on the summary page of the bid response form. This includes but is not limited to all installation equipment, rack accessories, cabling accessories, power strips, cabling, connectors, labels etc. Any item that the contractor feels needs to be included that is not priced in the 'Rooms' tab should be included on the alternate price tab. Please note whether the equipment in the alternates tab is a suggested alternate or a required addition needed to comprise a completely operational system.

P. Preventive Maintenance Services

1. As part of the First Year Warranty Period the Bidder shall include a one-year preventive maintenance service covering all installed systems and equipment. This Warranty/Service contract shall commence the day after acceptance of the systems by the Tenant.

2. The preventive maintenance service for the first year shall include four site visits by the AV Contractor to make adjustments to devices as may be required to maintain operational and image-quality performance of the system to manufacturer's specifications and as a system as a whole. The first site visit shall occur between 2 and 4 weeks after date of acceptance, and then every three months thereafter. The AV Contractor shall submit to the Tenant and Consultant a proposed schedule of dates for the four site visits. The Tenant will confirm the acceptability of the proposed dates.

3. The AV Contractor shall also submit separate costing for additional "On-Call" servicing, both in-house or in-shop, on a 24-hour response time basis and on an Emergency basis.

Q. Schedule of Implementation

1. The Bidder shall submit a scheduling plan with the bid return, indicating the various pertinent terminal dates after the award of contract for completion of the design, pre-installation work, on-site installation work, and testing and acceptance. The format of this plan should be in Gantt or CPM/PERT network form.

2. The Bidder shall obtain from the General Contractor projected dates when the relevant areas will be available for the on-site installation.

3. Any site condition which impedes the timely performance of the AV Contractor shall be brought to the attention of the Project Manager and Consultant by the AV Contractor.

4. Schedule milestones are to include but not be limited to the following:

    a. Purchase order received.

    b. Agreed upon equipment ordering date.

    c. Cutsheet submittals, substitution samples.

    d. Drawing submittals.

    e. In-shop fabrication.

    f. Job site equipment delivery.

    g. Installation, testing and burn-in.

    h. Training and final punchlist completion.

    i. Turnover and occupancy.

R. Sub-contract Information

1. The Bidder shall provide direct supervision of any sub-contracted work, and shall be fully responsible for the quality and execution of the work of that sub-contractor. The Bidder shall make known to the General Contractor the identity and scope of work of sub-contractors to be used on the job. Sub-contractors will not be permitted without the express prior consent of the General Contractor. Failure to inform the General Contractor of the use of a sub-contractor(s) may be considered breach of contract.

2. The supervision of such sub-contracted work cannot be intermittent, but shall be continuous during the installation.

S. The AV Contractor shall submit weekly field reports. Field reports shall include:

1. The AV Contractor firm name, address, phone, fax numbers and E-mail address.

2. Client name and location of job; date.

3. Project manager name, phone numbers, fax number and E-mail address.

4. Issues regarding project.

5. Work in progress.

6. Work completed since last field report.

a. All job related information is to indicate the individual room to which it refers.

b. The AV Contractor field report is to be E-mailed to the Tenant's representative and the AV Consultant by 3:00 pm weekly on Friday.

c. Field reports are required starting the second Friday after contract signing and concludes after all AV punchlist items have been completed.

d. The final audiovisual field report shall include:

(1) All information listed above with the exception of all project information is to be indicated as completed.

(2) The words "Final Audiovisual Field Report" appear as bold letters at the top of the page.

(3) Include client signoff document.

1.12 DESCRIPTION OF STANDARD AUDIOVISUAL ASSEMBLIES:

A. The AV Contractor shall be responsible for insuring that the installation of all equipment be performed in accordance with standard manufacturers specifications and installation methods. The necessity of special conditions required by a particular manufacturer shall be brought to the attention of the Architect prior to the installation of any equipment in the area concerned.

1.13 ALTERNATE PRICE QUOTATIONS:

A. Submit a separate price quotation for changes to the Base Bid audiovisual work for each alternate as described hereinafter.

1. All Base Bids shall be submitted on the basis of the specified equipment.

2. The Bidder may propose Alternative Equipment. However, all such proposals shall be identified as "Alternatives" with equipment costs shown separate and apart from the costs of the equipment specified.

B. Proposals for Alternative equipment will receive careful consideration if the differences do not depart from the overall intent of the design and operation of the system, and are in the best interests of the Tenant.

C. All such proposals for Alternative equipment shall be accompanied by full technical information and specifications. The Bidder shall identify the substantive differences between the Alternative and specified equipment.

D. Acceptance of the substitutions is at the Tenant’s sole discretion. The AV Consultant may act on behalf of the Tenant in accepting or rejecting proposed substitutions.

E. When a specified manufacturer's product has been superseded by a more recent model, the newer model shall be furnished, provided the performance retains or exceeds the characteristics of the item specified herein.

F. Should the Bidder have recommendations that will enhance the performance of the system, or reduce costs without loss of performance, such comments shall be made in the bid submission. All suggestions that are of value to the Tenant will be taken into consideration in the evaluations of the bid returns. All such proposals shall be made as "Alternatives," with the appropriate cost modifications shown separate and apart from the costs of the AV Base Bid system as specified.

G. Any and all exceptions to these specifications and related drawings must be made with the bid submission. In the absence of exceptions, these specifications and related drawings shall be binding in letter and intent on the successful Bidder. It will further be assumed that the Bidder has examined the design and specifications in detail, and is prepared to take full responsibility for the performance of the complete installation.

1.14 WORK INCLUDED:

A. Audiovisual materials and services as described in this AV Specification Section 27 41 00 and on the accompanying AV Specification Drawings.

1.15 RELATED WORK:

A. General Contractor Contract Documents.

B. Telecommunications Systems. AV Contractor must coordinate with the Telecom drawings.

C. Electrical Specifications. AV Contractor must coordinate with the Electrical drawings.

D. Lighting Specifications. AV Contractor must coordinate with the Lighting drawings.

1.16 REFERENCES:

A. Local Applicable Electrical Code

B. Local Applicable Building Code (and Reference Standards)

C. Sound System Engineering. Fourth Edition, Don and Carolyn Davis, Howard Sams & Co. The Chapter on "System Installation" is the AV Contractor's reference for acceptable installation and wiring methods for AV.

D. The AV Contractor shall utilize the manufacturer's published recommended installation and termination instructions, methods, and tools for crimp connections and all other termination devices. The AV Contractor shall submit such instructions to the Electrical Contractor performing the terminations of any and all low voltage AV signal cables, connectors, Jack plates, etc.

E. Instrumentation Fundamentals and Applications, Morrison, Wiley Interscience, NY 1984. Reference for grounding and shielding techniques.

PART 2 - PRODUCTS

A list of specified AV equipment is appended to this Specification under the heading, "AV Bid Response Form."

PART 3 - EXECUTION

3.1 WORKMANSHIP AND INSTALLATION PRACTICES:

A. The AV Contractor shall use professional quality workmanship in all aspects of the installation, including neat and orderly dressing, strain relief and labeling of all cables.

B. The AV Contractor shall set up and adjust each variable component of the system using calibrated signal generators and signal analyzers, as may be required, to optimize the gain-structure and overall performance of the system, as per manufacturer's specifications and good system engineering practices. Wherever applicable the AV Contractor shall use the setup and convergence procedures specified by the manufacturer to assure proper adjustment of said components. This includes but is not limited to a complete setup of all video and audio components, monitors, projectors, cameras, recording and playback devices, scan converters, modems, fiber optic components, codecs. In addition all serial and/or parallel device control protocols i.e., RS-232C, RS-485, RS-422 and related data control signals must be tested and conform to industry standards and practices unless specified by the manufacturer of said equipment. Signal Transport i.e. fiber optics, ISDN, wireless, webcasting, satellite transmission reception and all forms not mentioned in this document which appear in the project design must be tested. These setup parameters and results shall be submitted to the Consultant for review prior to system Acceptance Tests.

C. The images and sound at any and all selected AV jacks and systems in the facility shall be judged, by the Tenant and AV Consultant, to be free of visible ghosting, snow, hum, noise or distortion beyond that which is evident at the source. Professional quality broadcast monitors shall be used as the reference hardware for subjective image tests, using SMPTE and/or AES reference video and audio program material. If signal degradation, as judged by the Tenant or AV Consultant, is evident anywhere in the system, the AV Contractor shall make such adjustments as required to eliminate such signal degradation, at no further cost to the Tenant, if the signal degradation is outside of the expected performance of the installed components, and due to a deficiency in the workmanship, installation, or setup practices of the AV Contractor.

D. The AV Contractor shall test each and every component and jack plate location of the system once installed, in the presence of the Tenant and Consultant if so requested, to provide visual and measured proof of performance at any one or more selected locations in the facility. The AV Contractor shall demonstrate all functions of the system.

E. All equipment, except portable equipment, shall be fixed firmly in place. Equipment cabinets and mounts shall be square and plumb, and fastenings and supports shall be adequate to support their loads with a safety factor of at least three, and as specified elsewhere in this document.

F. The AV Contractor shall take whatever steps are necessary to prevent hum or interference from electromagnetic and electrostatic fields, to supply adequate ventilation in equipment cabinets, to prevent equipment vibration and to install equipment so as to provide maximum safety to the operator. In the case of interference determined to be caused by building systems or building ground, the AV Contractor shall document the problem to the AV Consultant for resolution with the project team.

G. All wiring and termination shall be in strict conformity with all applicable National, State and local electrical codes. Low voltage audio, video, and control wiring and connections shall be in conformance with those rules and practices as stipulated in "Sound System Engineering, Second Edition" by Don and Carolyn Davis (Howard Sams and Co.), and in accordance with good industry standard practices.

H. Isolated Terminal blocks and connector panels should be provided in all equipment cabinets and wiring boxes for incoming and outgoing cables. Terminal blocks shall be labeled with engraved laminated plastic legends fixed in place with a suitable permanent adhesive. "Dymo-Labels" and similar semi-permanent labeling will not be acceptable anywhere in the facility. All conductors shall either be marked with approved pressure sensitive tags or identified by color code. When color coding is employed in lieu of tagging, a cable schedule shall be prepared on 8 ½" x 11" acid-free paper or vellum, inserted into a suitable transparent holder and the schedule shall be hung inside the cabinet or box. Copies of the schedule shall be included in the As-built file.

I. The AV Contractor shall perform all work in a neat and workmanlike manner. He/she shall assign workmen to the job in numbers sufficient to meet the schedule commitments and insofar as it is reasonable, the same person shall remain in charge of the work from its inception until completion.

J. Connector panels shall be inset at least 3" from the rear plane of the rack to allow cable management and strain relief without extending beyond the rear plane of the rack. Panduit should be used on the rear of the rack to distribute in a neat and orderly fashion all cables to the appropriate connector panel or AV Component. Rear rack rails should be inset to accommodate the connector panels. All cables shall be strain-relieved. All cable bundles within or on the racks shall be use Velcro wire loops at least every 6", or as appropriate. No wire ties shall be used, so as to prevent crimping or damage of internal conductors.

K. Cables should always be home runned from one connection to another connection with no barrels or terminal blocks unless specified in the design or unless approved by the consultant.

L. Any rooms or spaces which have movable/portable furniture shall have all AV cables terminated in the floor box/wall box. No cables shall be run through grommet holes in floor boxes or wall boxes if the associated furniture is movable and/or reconfigurable. All cables must have disconnects if furniture is not permanent.

M. The AV Contractor shall submit shop drawings showing full-scale connector panels and their labels, prior to fabrication, for approval.

N. The AV Contractor shall provide all rack hardware and accessories as needed for completely finished racks. This includes, but is not limited to, shelves, blank panels, vent panels, side panels, power distribution hardware (approved by local codes), and all other accessories. There shall be no open spaces visible on the front plane of the racks. All rack mounted monitors will be provided with rack mounts providing custom fit equipment-surrounds without visible gaps. Where required due to equipment heat dissipation, intake and exhaust fans shall be provided for each rack.

O. The AV Contractor shall submit, for approval, front-view elevations and rear-view elevations of racks showing hardware location and wiring scheme, prior to assembly.

P. The AV Contractor shall provide all AV Jack plates with connectors as indicated by function on the drawings. The AV Contractor shall submit for approval, prior to fabrication, full-scale drawings of each type of jack panel. Each connector shall have engraved labels which are keyed to the As-built set of drawings.

Q. Where applicable, the AV Contractor shall manufacture connector panels for the inside of the floor boxes, with an electrically isolated connector for each cable entering or leaving the box. The connectors shall be permanently labeled as to function and/or wire number, keyed to the As-Built Drawings.

R. The AV Contractor shall adjust each variable parameter of each computer interface in each room to optimize signal quality when viewed on displays in the facility. These adjustments include, but are not limited to, "peaking" controls, horizontal and vertical centering, gain controls, dip-switch settings, etc., as to optimize performance of the interfaces, and to name and program pre-sets for each anticipated type of user-provided computer.

S. During the course of the project and installation, the AV Contractor shall develop a completion list of non-completed tasks required to execute final sign off of the Systems.

T. The AV Contractor shall submit, for approval, an Acceptance Test Approval Form to be used during System Acceptance Tests.

U. The AV Contractor shall be responsible for warehousing of all equipment included in the Bid Specification until such time as appropriate to install such equipment at the job site.

V. The AV Contractor shall schedule an Acceptance Test with the Tenant and AV Consultant. During that process, the AV Contractor shall be required to take the Tenant and AV Consultant to each and every part of the system, and prove to the satisfaction of the Tenant and AV Consultant that all systems are installed in accordance with the AV Specifications, and that all systems are operating normally. If there are non-acceptable elements of the installation, as determined by the Tenant or AV Consultant, the AV Contractor shall immediately schedule repairs and modifications as will be needed to bring the Systems into accord with the Specification, at no further cost to the Owner.

3.2 TRAINING:

A. At its discretion the Tenant may assign one or more persons to participate with the AV Contractor's personnel during installation of the AV System. In this case, the AV Contractor, without delaying his work, shall familiarize the Tenant with the system's components and installation.

B. During initial tests and adjustments, the AV Contractor shall permit the Tenant to observe and shall explain, when feasible, the significance of each test.

C. The AV Contractor shall provide with his bid a schedule showing the number of days of on the job training required for familiarization with the system drawings, manufacturer's literature, and hands-on operation of the AV systems for ongoing support in the form of instructor led training with documentation (i.e. PowerPoint presentation or similar documentation). The Bid should allow one training class per each unique system type, including development time of the material and delivery of the training.

D. End user documentation shall be provided in a format that includes accurate screen prints and instructions on how the end user operates the user interfacing equipment (touch panel). The Bid should allow one instruction document per each unique system type and include development time of the material and final publication of the document that will be placed in the AV space. This documentation will be free and clear of all AV Integrator or AV Consultant labeling or references. The documentation will be reviewed by Global Public Affairs to ensure approved logos and consistency between the various system types.

E. Training shall not be deemed completed until the Owner, Tenant, and AV Consultant have determined that the Tenant is adequately trained to operate the system and to perform routine maintenance.

3.3 COORDINATION:

A. The AV Contractor shall coordinate and cooperate with other trades to ensure satisfactory work progress.

B. If minor moves or changes are necessary to accommodate other equipment, with or at the Owner's request, such changes shall be made without claim for additional payment.

C. When an AV system interfaces with other equipment, such as floor boxes, the AV Contractor shall provide in his equipment cabinets and boxes readily identifiable terminal strips or connector plates to which interfacing cables may be connected. He shall coordinate with other suppliers to ensure the appropriateness of the interface.

3.4 IDENTIFICATION AND TAGGING FOR AUDIOVISUAL DEVICES:

A. Although labeling of both ends of field cables is by the subcontracted EC, the AV Contractor shall incorporate all EC field cable numbers and all AV Contractor in-rack numbers as part of the AV as-built documents to be submitted at the completion of the project. The AV Contractor shall identify, for the EC and for the final as-built AV drawings, discrete identification numbers for all AV devices which includes, but is not limited to:

1. Each and every audiovisual cable.

2. Each fiber optic cable and fiber strand associated with AV.

3. Each AV junction box.

4. Each termination block and patch panel (and each termination -- front and rear as applicable).

5. Each equipment termination frame and cabinet.

6. Each raceway and junction box used for audiovisual wiring.

7. Other items as directed by Consultant.

B. The nomenclature used to identify cables, blocks, equipment, etc. shall be as approved by the Tenant or AV Consultant. Missing or unclear nomenclature criteria for the items specified above shall not be construed as a reason not to identify the items and shall be brought to the AV Consultant's attention.

C. All materials required for labeling shall be provided by the AV Contractor. All labels shall be permanently adhered, easily visible and shall be smudge-proof. All text shall be typed (not handwritten). All cables shall be labeled at both ends minimum.

D. Identification of all equipment, racks, bulkheads, patch panels, systems, etc. shall be by means of engraved lamacoid (or approved equivalent) nameplates showing 1/4" high white lettering on a black background fastened in the upper left hand corner of all equipment, where feasible. An attempt shall be made to place the label in the same location on similar equipment. The contractor shall submit for approval by the Consultant any nameplates intended for application to AV equipment prior to attaching any nameplates.

E. Identification for the wires and cables shall be by means of wrap around "brady" type labels, or approved equivalent.

F. Device plates for patch panels, miscellaneous termination hardware, electronic equipment (i.e., controllers, multiplexers, etc.) whose function is not readily apparent shall be engraved with 1/8" high letters suitably describing the equipment controlled or system served.

G. Identify each outlet box, junction box, and cabinet used in conjunction with empty raceway for wires of a future system by means of indelible markings on the inside denoting the system.

H. Prior to installing identifying tags and nameplates, submit their nomenclature for approval. Conform to all revisions issued by the Architect and/or AV Consultant.

I. Junction boxes used for audiovisual wiring and located in unfinished spaces (i.e., hung ceilings, equipment rooms, etc.) shall be clearly identified on the outside as per EIA/TIA-606 Standards unless specified otherwise.

J. All labeling and identification information shall be provided as part of the As-built drawings as specified elsewhere.

K. All AV devices with serial numbers shall be labeled. All phones installed in meeting rooms by the AV Contractor shall be labeled with the phone number, based on label types and locations (to be provided).

3.5 CABINETS AND ENCLOSURES:

A. When fed from above, a smooth grommetted hole (sized as required and no less than 2" inside diameter) shall be provided in the top back corner of the equipment cabinet opposite the electrical plug strip in the cabinet (if any). The opening shall be provided with a non-conducting grommet so as to protect the cable from any sharp edges.

B. All rack mounted equipment which can be serviced from the front side of the rack shall include rack rails or similar and provide cable service loops to extend equipment outward for service without disconnection or removal.

C. Cabling run in equipment cabinets shall be routed vertically and horizontally in a squared-off manner. The cables shall be secured to the cabinet framing members with color coded Velcro cable ties, or approved equal. All cables connected to an item of equipment or patch panel shall approach the device from the door hinge side of the cabinet (i.e., right or left). The cables shall be neatly bound and dressed, with strain relief on each and every cable. All rack mounted equipment which can be serviced from the front side of the rack shall include rack rails or similar and provide cable service loops to extend equipment outward for service without disconnection or removal. The AV Contractor shall provide and install black cable "Snakeskin" mesh braided cable sleeve to encase any cable bundles that are exposed to view at tabletop locations and at other locations where neat dressing of cables is appropriate. There shall be no visible multi-cable runs or umbilicals without the use of braided cable sleeve. The Contractor shall take measures to prevent fraying or damage to both ends of the cable mesh using a method to be approved by the AV Consultant prior to deployment.

D. Where the rack is movable, the AV Contractor shall provide a cable loop of sufficient length as to provide access to the rear of the rack for maintenance, by moving the rack perpendicular to its normal position, for full access to the rear of the rack. There shall be strain relief for any and all cables which are part of a movable rack cable loop.

E. Where possible, for cabinets placed on raised floor tiles, the AV Contractor shall coordinate with the raised floor contractor to ensure that tile openings are properly sized, located and are edge cut to facilitate the removal of the tile after cable is installed. The contractor shall also verify the ability to remove tiles in the front and rear of cabinets to ensure access under the cabinet.

F. Forced air ventilation shall be provided for each rack by the AV Contractor, unless otherwise noted, of sufficient CFM rating as to adequately cool the AV equipment mounted in the rack.

G. Two 20 amp plug strips with outlets mounted 6" on center shall be provided as part of the cabinet. The plug strips shall be mounted in the rear of the cabinet opposite the rear door hinge. The plug strips shall be suitable for hard wiring to electrical junction boxes. Final connection will be by others.

H. Equipment/patch panel mounting rails within cabinets shall be adjustable from front to back within the cabinet.

I. Cabinets located on a raised floor shall be positioned so as to cover a single tile (where possible).

J. Cabling which runs between cabinets shall be via the raised floor (where available unless specified otherwise). AV Contractor shall coordinate with the floor contractor. Generally, the front plane of the rack(s) shall be within 2" of the floor's T-bar support structure. Cables run between cabinets with no raised floor shall be run at the top or bottom along the back of the cabinet.

K. A minimum of 2-6" clear shall be maintained in front and behind cabinets. Cabinet doors shall open toward the nearest wall when the cabinet is located within 5'-0" of the wall.

L. Where multiple runs of small diameter cabling are installed vertically within cabinet enclosures (i.e., between patch panels and/or equipment), they shall be run in panduct L or C type raceway fastened to cabinet framing members. Raceways shall be sized as required.

M. For racks located on raised floors, the AV Contractor shall coordinate with the raised floor vendor to ensure proper sized openings are provided and located in the raised floor tile for unobstructed routing of the cabling.

N. Cabling for connection to rack mounted patch panels and equipment shall be dressed such that the labeling of the patch panels and/or equipment is readily visible and access to said items is not obstructed.

O. Each rack shall be provided with an equipment ground assembly.

P. For items of equipment which are indicated as being rack mounted and for which no rack mounting hardware is available, a fitted rack mounted equipment shelf shall be provided, providing for no visible gaps adjacent to the mounted hardware. Custom fitted rack mounts shall be by Middle-Atlantic Products, or approved equal.

Q. Horizontal wire management panels shall be provided as necessary to ensure a neatly dressed installation.

3.6 MOUNTING HEIGHTS:

A. Heights of all wall mounted outlets and other AV devices shall be in accordance with the Architect's drawings.

3.7 SUPPORTS:

A. Support work shall be in accordance with best industry practice and shall be plumb and true.

3.8 FASTENINGS:

A. Fasten audiovisual work to the building structure, where applicable, in accordance with the best industry practice and with a safety factor of at least three.

3.9 TESTING:

Where applicable the following test devices shall be used:

A. Audio Tests

1. Distortion Analyzer
2. Audio/Video Oscilloscope
3. Volt Meter
4. Audio Signal Generator
5. Sound Pressure Level Meter
6. TEF or MLSSA analyzer

B. Video Tests

1. Dual-input Waveform Monitor
2. Vectorscope
3. Video Pattern Generator and SMPTE bars
4. SMPTE Test Tapes
5. Computer test-signal generator
6. Broadband video sweep generator
7. Broadband video spectrum analyzer
8. QuantumData 780

C. Data and Digital Signals

1. Data capture.
2. BER testing.
3. Timing-reclocking.
4. EDH testing.
5. Bit rate verification.
6. Fluke Linkrunner

D. The AV Contractor shall deliver the rack portion of the AV System pre-wired and pre-tested.

E. The AV Contractor shall include the cost of setup and performance tests in his bid proposal.

F. Prior to system acceptance the AV Contractor shall completely set up and test the systems as a whole to confirm that overall performance meets the expected performance based on equipment specifications and proper interfacing and gain structuring techniques.

G. If subjective performance is deficient as far as signal-to-noise, Total Harmonic Distortion, and gain-before-feedback, for the audio subsystems, the AV Consultant and Tenant will require OBJECTIVE tests. For video subsystems, image sharpness, contrast, focus, and convergence will be considered. Objective tests will be required if image quality is deficient from expected product specifications and the system as a whole, as determined by the Tenant or AV Consultant.

H. Time and skilled personnel must be allocated as part of the AV Contractor's scope to perform off-line setup configurations and level adjustments for each system, and on-line tests with personnel at far end sites and the near end site (for audio and videoconferencing) for final adjustments.

I. After setup, all levels of each pot, as well as nominal meter ranges shall be clearly documented in the technical manual for that room. In addition, where feasible, and only after on-line successful tests, pots and levels that can be marked on the hardware itself shall be so marked.

J. Please reference Appendix A for the comprehensive list of tests that may be expected to be performed.

3.10 TEST EQUIPMENT:

A. Prior to any testing being performed, the AV Consultant shall be supplied with a list of test equipment to be used, for his review and approval. The submittal shall include documentation indicating that the proposed equipment is capable of performing all of the tests required to execute the successful installation and certification of the AV systems.

3.11 TESTS TO BE PERFORMED:

A. Tests are to be performed on the following aspects of the audiovisual system for large venues with speech reinforcement systems:

1. Raw unequalized house curve through program speakers using pink noise

2. Ambient noise measurements placed on NC template

3. RT60 reverberation time

4. Gain structure chart showing measured levels at each and every variable gain point through the system. This will be submitted as the reference setup for the system upon system completion.

5. Available headroom before clipping for each input stage. This information may be placed on the gain structure chart.

6. Feedback Stability Margin for speech reinforcement system, which should be at least 6 dB.

B. Video Format Types - Which may be part of the design include, but are not limited to; Composite and Component Analog Video, Serial and Parallel Digital Video, HDBaseT, Standard Definition all various formats of High Definition Video. Computer generated RGB or DVI or Displayport formats and resolutions.

C. New Formats and Emerging Signal Types - It shall be the responsibility of the AV Contractor to be fully experienced in new and emerging forms of video delivery protocols as it relates to video systems used in the design. This includes but is not limited to MPEG and similar streaming video as well as media transfer types, i.e. IEEE 1394, USB, SCSI or any additional types of media transfer protocols not described herein. The AV Contractor should have a full understanding of the process of encoding and decoding various formats.

D. Video/Audio and Data Testing

1. All Video/Audio and Data Testing shall be done using the prescribed test equipment outlined in section 3.10 and may include additional test components offered by the AVContractor. It is the responsibility of the AV Contractor to provide all test equipment electronics, harnesses and adapters to perform tests. All AV Contractor Test equipment must bear the latest calibration sticker issued by that device's manufacturer or manufacturer approved calibration service.

E. Video Signal Distribution and Timing - (All Formats)

1. All video systems shall conform to the required proper testing of all aspects of the video signal and the related format. Testing parameters shall where applicable conform to the specified video format standard(s) for analog and digital Formats.

2. Signal distribution adjustments shall include unity gain where applicable to achieve a proper signal amplitude for video, pulse and audio signals. Signal distribution adjustments shall also include Gain and Equalization adjustments for cable length compensation where required. This includes proper cable lengths and equipment adjustments to ensure correct horizontal and sub-carrier timing and reclocking for digital formats. No equipment shall use input video auto-timing unless approved by the consultant. No devices shall use AGC for gain control unless approved by the consultant. All devices which are deemed as part of the clause include but are not limited to;

   a. Cameras, Video Recording Devices, Distribution Amplifiers, A to D and D to A converters, Signal generators, Frame Synchronizers, Time Base Correctors, Routers, Standards Converters, Transcoders, Fiber Optics, and Video Processors.

3. All Video testing must conform to the guidelines set forth by SMPTE, NTSC, AES, EIA, IEEE, FCC, and ASTC where applicable.

4. All signal testing and optimization shall be made on short haul systems and long haul systems end to end when applicable.

F. Color Video Monitors and Projectors: Where appropriate as reference or for system testing, the color video monitors shall be of broadcast grade and capable of displaying the signal format and/or additional formats being used. . This includes but is not limited to all analog and digital, composite and component video formats. Standard and high definition resolutions. All additional resolutions. Monitors where appropriate shall provide cross pulse and under-scan features for testing purposes. Monitors should have blue only feature for color phase (hue) calibration.

1. Calibration: All Color Video Monitors/Projectors shall be calibrated with test generated signals including SMPTE Color Bars to adjust setup, brightness and colorimetry.

2. Computer monitors shall be calibrated using appropriate computer test signals or using the display or video graphics adapter manufacturers LUT (lookup table) or calibration application.

3. Convergence, linearity and geometry should be observed for defect and corrected during installation unless mechanical defect warrants manufacturer servicing.

4. Other Display Devices:

   a. Computer LCD displays: All LCD displays shall be sized according to the ergonomic integration into the end users work environment. LCD displays shall be calibrated using appropriate computer test signals or using the display or video graphics adapter manufacturers LUT (lookup table) or calibration application.

   b. All panels should be observed for defect such as excessive "dead pixels" and returned to the manufacturer for servicing or replacement.

3.12 RECORD OF TEST RESULTS:

A. A record of all required tests shall be provided to the AV Consultant and Tenant. The information shall be maintained as permanent record for the purposes of maintenance and restoration.

B. A brief description outlining the test equipment used and a single line diagram indicating the test setup shall be provided to the AV Consultant for his review. The level of description should be sufficient enough to allow an individual who is not familiar with the specific test equipment to recreate any portion of the test.

C. Test results to be provided shall contain the following minimum information:

   1. For all similar tests include:

      a. Project name

      b. Description of test

      c. Source origin

      d. Source destination

      e. Cabling Scheme to be determined by Tenant

      f. Cable pair/strand

      g. Test date

      h. Tester (individual responsible for conduct of the test)

      i. Page __ of __.

      j. Levels of signal, and reference of dB ratio

      k. Settings of all pots on equipment

      l. Graphs and observations

D. All test results shall be provided in the following formats:

1. Printed (3 bound copies)

2. Permanent digital format as dictated by client.

3. The test equipment shall have the ability to record test results to a printer or memory for printing later. Submitting of these printed test forms is preferred in lieu of handwritten forms.

4. The test results are required to be submitted electronically per instruction from the Architect to associate the information with a cable database.

E. A copy of the test results in both electronic and printed formats shall be provided to the AV Consultant for his review and the Tenant for his records.

3.13 CORRECTIVE ACTION:

A. Any defects or deficiencies discovered in any of the audiovisual work shall be indicated on the test report and be corrected, at no further cost to the owner.

B. Upon completion of testing and problem resolution, all connections tested are to be 100% error free.

C. Any connections determined to be not correctable shall be indicated at each end of the termination as "bad" (in red).

D. For those systems requiring specialized setup and or skills not employed by the AV Contractor, the AV Contractor must coordinate prior to delivery, a certified onsite engineer or equivalent to certify the proper installation, programming and testing of the said equipment or system at no additional charges to the owner. If the equipment is delivered, installed and requires the attention of additional personnel to configure, program and or test it, than the owner is not responsible for any additional charges unless approved by the owner.

1. Systems which may require such specialized assistance include but are not limited to:

a. Cameras, , Automated switching, Computer based Video/Audio Systems, Video/Audio/Data Routers, Router Control Systems, Fiber Optic Systems, Machine Control, Graphics/Digital Audio/NLE Workstations, Intercom, Telecommunications systems and Computer Networked Systems, Projectors, automatic microphone systems, KVM systems, etc.

3.14 EQUIPMENT INSTALLATION AND TESTING:

A. The AV Contractor shall be available during equipment installation and testing to help isolate faults which may exist in the cabling system installation.

B. The AV Contractor shall coordinate with other vendors where necessary to resolve any discrepancies between the cabling system and the vendors cabling or equipment.

3.15 AUDIO PERFORMANCE CRITERIA:

A. Definition of terms: The "Audio System Performance Criteria" set forth in this section will define the parameters of acceptable performance of the Audio System.

B. The attributes of system performance are divided into two sets of criteria: Subjective and Objective Criteria.

C. Subjective Audio Performance Criteria: The AV Contractor is required to use subjective listening tests to determine if the system will meet the expected performance criteria, as well as the objective requirements of high quality audio installations. The AV Contractor must subjectively evaluate the system in terms of frequency response, intelligibility, loudness, and noise transmission. Listening test should be performed while the system is transmitting typical audio material (including speech) and operating at nominal level.

D. All audio systems should fall within the specified ranges stated in this specification.

E. Any signal level adjustment is to be made such that it does not alter the signal integrity of any other system.

F. Objective Audio Performance Criteria:

1. It is the AV Contractor's responsibility to assure the audio system operates within standard audio system performance criteria, whether or not the criteria are explicitly delineated herein.

G. Electro-acoustic Signal to Noise:

The following are expected Electro-acoustic signal to noise ratios for various systems:

Program Systems	20-26 dB
Amplified Speech System (NOM=1)	20-26 dB
Amplified Speech System (NOM=2)	17-23 dB
Amplified Speech System (NOM=4)	15-21 dB
Mix Minus System (NOM=3)	1-13 dB
Audio Conference System	15-20 dB
Video Conference System	15-20 dB
Studio Systems	40-45 dB

H. It is expected that Electro-acoustic Signal to noise test will be conducted in the following manner:

1. Electro-Acoustic System Signal to Noise Test:

a. Reading A: Measure the ambient sound pressure level with a sound Level meter (wide band A weighted). Note readings at various points in the room. Also note any points in the room that result in measured changes greater than + or - 3 dB S.P.L.

(1) Room Ambient Noise Level: The maximum acceptable ambient noise level for audio rooms under this specification is NC 35 (Noise Criteria) This translates to a wide band A weighted noise floor of 46 dB SPL.

b. Introduce nominal sound into the room using the specified system components.

(1) (Audio conference system, mic system, program system).

c. Reading B: Measure sound in the room using the sound level meter (A weighted). Note the level readings at the same points as the ambient test.

d. Subtract reading A from reading B. This is the Electro-Acoustic Signal to Noise Ratio for that system.

I. Audio Bandwidth:

The audio systems to be installed in this project are to have the following minimum bandwidth(s):

The bandwidth of a system is measured as + or - 3dB of the Audio frequency bandpass.

Program Systems (no subwoofer)	40-20kHz
Program systems (subwoofer)	20-20kHz
Amplified Speech System	150-15kHz
Mix Minus System	300-15kHz
Audio Conference System	300-7kHz
Video Conference System	300-7kHz
Studio Systems	20-20 kHz

J. Signal to noise:

It is the AV Contractors responsibility to provide electronic systems that have a minimum electronic signal to noise ratio of -55 dB, unless otherwise specified herein. For studio systems the overall minimum signal to noise ratio is 65 dB.

K. Total Harmonic Distortion:

1. The Audio systems are to have the following maximum distortion levels:
2. Program Systems (no subwoofer) 0.5%
3. Amplified Speech System 0.5%
4. Mix Minus System 0.5%
5. Audio Conference System 1.0%
6. Video Conference System 1.0%
7. Studio Systems 0.2%

L. Overall System Headroom:

1. It is the responsibility of the AV Contractor to set up the system to meet the following minimum headroom requirements:

Program Systems	10 dB
Amplified Speech System	15-20dB
Mix Minus System	6-12dB
Audio Conference System	3dB
Video Conference System	3dB
Studio Systems	24dB

M. Level Matching:

It is the responsibility of AV Contractor to verify the proper level matching of system components. The components are to operate within the sensitivity specification provided by the manufacturer.

N. Mismatching of levels:

1. Any level mismatching between system components defined in this design is the responsibility of the AV Contractor to recognize and correct in the submission drawings at no cost to the owner.

2. Any level mismatch caused by the substitution of equipment is the responsibility of the AV Contractor to recognize and correct.

3. Any level mismatch caused by the addition or substitution of Tenant furnished equipment is to be presented to the consultant within one week of the identification of the manufacturer and model number of Tenant supplied equipment. The AV Contractor will present the proper interface solution, cost and availability of the device(s).

O. Field verifications:

1. It is the AV Contractor's responsibility to notify and recommend solutions to the Architect and AV Consultants if for any reason the Audio System Performance Criteria cannot be met due to changes in field conditions, equipment, or additional requirements of the system or if these changes render the performance criteria to be insufficient. The AV Consultant reserves the right to alter the performance criteria to meet changing field or system conditions.

END OF SECTION

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Appendix A:

AP-100 : Emergency Systems Muting	Verify that any required muting or operational change of the installed sound system(s) has been made in accordance with local requirements and/or design specifications in the event of a life safety or similar emergency.
AP-101 : Loudspeaker Zoning	Verify that loudspeaker zones are wired as defined in the project documentation.
AP-102 : Alignment of Multiple Audio Source Levels	Verify calibration of permanent audio system inputs such that the difference between any input signal level after the first common gain adjustment meets the requirements of the project documentation.
AP-103 : Audio Buzz and Rattles	Verify that no audio noise caused by improper installation of any equipment provided in completed system(s) is present.
AP-104 : Audio Routes	Verify that all audio routes are tested from endpoint to endpoint via the appropriate midpoint(s) for operations and routing as defined in the project documentation.
AP-105 : Reverberation Time	Verify reverberation time meets the requirement defined in the project documentation.
AP-106 : DSP Programming	Verify that all DSP-based products have been programmed as defined in the project documentation.
AP-107 : Loudspeaker Physical Alignment	Verify that loudspeakers are placed and aimed as defined in the project documentation.
AP-108 : Loudspeaker Polarity	Verify that loudspeakers have correct polarity as defined in the project documentation.
AP-109 : Loudspeaker Time Alignment	Verify that loudspeaker time alignment performs as defined in the project documentation. This verification item shall require a metric to be verified.
AP-110 : Phantom Power	Verify that phantom power is provided at the correct voltage and correct locations as defined in the project documentation.
AP-111 : Loudspeaker Transformer Tap Settings	Verify the loudspeaker transformer tap setting in constant voltage systems is as defined in the project documentation.

AP-112 : Acoustical Ambient Noise	Verify that the background acoustic noise levels within audio-visual spaces are within the required limits as detailed in the project documentation. This test is specifically related to ambient noise levels and not audio system quiescent noise, which is tested separately. This verification item shall require a metric to be verified.
AP-113 : Assisted Listening Devices	Verify that all devices that are part of the assisted listening system have been tested as a complete end-to-end personal listening system. Verify that the assistive listening system complies with regulatory requirements and adheres to project documentation.
AP-114 : Audio Coverage in Listener Areas	Verify that coverage of the audio systems in listener areas meets the performance requirements as defined in the project documentation. ANSI/INFOCOMM 1M-X009
AP-115 : Audio Dynamics	Verify use of audio dynamics, including but not limited to noise compensation, automatic gain control, gating, feedback suppression, compression, limiting, delays and levelers meet the design requirements defined in the project documentation.
AP-116 : Audio Level Exceeds Background Noise Level	Verify that the audio level provided by the installed audio system exceeds the background noise level as defined in the project documentation.
AP-117 : System Electronic Frequency Response	Verify that the electronic frequency response of the audio system is as defined in the project documentation. This verification item shall require a metric to be verified.
AP-118 : Audio System Equalization for Spectral Balance	Verify that the audio system equalization is in accordance with the acoustic response curves as defined in the project documentation. This verification item shall require a metric to be verified.
AP-119 : Audio System Latency	Verify that audio system latency meets requirements defined in the project documentation. This verification item shall require a metric to be verified.
AP-120 : Audio System Speech Reproduction at Listener Positions	Verify that the audio system provides speech reproduction (intelligibility) as defined in the project documentation.
AP-121 : Audio System Total Harmonic Distortion	Verify that the total harmonic distortion of the installed audio system is as defined in the project documentation.
AP-122 : Conferencing Audio Levels	Verify that in a conferencing audio application, the incoming and outgoing audio levels are checked and adjusted in the system as defined in the project documentation. This verification item should require a metric to be verified.

AP-123 : Conferencing Echo Suppression Performance	Verify that a system with conferencing capability performs at nominal operating levels in a full duplex mode with echo and latency performance as defined in the project documentation.
AP-124 : Loudspeaker Impedance	Verify that all loudspeaker circuits have the correct impedance as defined in the project documentation.
AP-125 : Microphone Alignment and Placement	Verify proper alignment and placement of microphones in the system as defined in the project scope. Verify that the correct type of microphone is used in accordance to project specifications.
AP-126 : Microphone Gain Before Feedback	Verify that the speech reinforcement system is operating without feedback and at audio levels as defined in the project documentation.
AP-127 : Microphone Level Alignment	Verify calibration of microphone inputs so that the difference between any input signal level after the first common gain adjustment meets the requirements of the project documentation.
AP-128 : Multi-channel Loudspeaker System Output	Verify that the audio outputs of a multi-channel loudspeaker systems are assigned correctly to designated outputs as defined in the project documentation.
AP-129 : Sound Masking	Verify that audio system sound-pressure levels and equalization are adjusted to the level of sound masking as defined in the project documentation. This verification item shall require a metric to be verified.
AP-130 : Audio Reinforcement System Headroom	Verify that the audio system is capable of performing above nominal operating levels without distortion as defined in the project documentation.
AP-131 : Audio System Signal-to-Noise Ratio	Verify audio system electrical signal-to-noise ratio meets the minimum levels defined in the project documentation. This verification item should require a metric to be verified.
VP-100 : EDID Management Plan	Verify that the EDID management plan has been implemented per the project documentation.
VP-101 : HDCP Management Plan	Verify that the HDCP management plan has been implemented as defined in the project documentation.
VP-102 : Projected Display Physical Alignment	Verify that the combined installation of projector and screen provides a displayed image that is correctly aligned to the active projection screen surface without misalignment unless an alternative condition is specified in the project documentation.

VP-103 : Video System Pixel Failure Tolerance	Verify that all displayed images do not have pixel failures that exceed the requirements of the project documentation or the manufacturer's specifications.
VP-104 : Image Geometry	Verify that all displayed images are correctly focused, have the correct image geometry and are free from distortion such as stretching, keystone, barrel/pincushion.
VP-105 : Displayed Image Performance	Verify that the components of the displayed image systems perform as required with relation to image size, viewing angles, sight lines, viewer locations and/or any other requirements as defined in the project documentation.
VP-107 : Multiple Resolution Performance of Video Displays	Verify that the system accurately displays all resolutions required by project documentation on all displays within the system with no pixel shift, geometric distortions, no artifacts from scaling, letterboxing, pillarboxing or windowboxing.
VP-108 : Projected Display Brightness Uniformity	Verify that the combined installation of projector and screen provides a display to the viewer that meets the requirements of the project documentation. This verification item shall require a metric to be verified.
VP-109 : Projected Image Contrast Ratio	Verify that the system conforms to the appropriate viewing category as defined in the project documentation. The testing methodology in ANSI/INFOCOMM 3M-X011 shall be used. The projected image contrast ratio shall be measured for all projected images within the system.
VP-110 : Test Video Routes	Verify that all video routes are tested from endpoint to endpoint via the appropriate midpoint for operation and routing required by the project documentation.
VP-111 : Video Camera Image and Operation	Verify that the camera's, lenses and pan/tilt systems operate as defined in the project documentation. Inspect the camera image through the full lens operation.
AVP-100 : Emergency Communications	Verify that the emergency communications systems properly receive inputs and information from other systems (including but not limited to life safety systems, security systems and weather notifications), deliver appropriate notifications to target audiences, comply with regulatory requirements and adhere to requirements defined in the project documentation.
AVP-101 : Genlocking (Video Synchronization)	Verify that the video synchronization of the system is performing as defined in the project documentation.
AVP-102 : Audio and Video Recording	Verify that audio and video signals are being routed to the recording devices and that the recording device is operating correctly, as defined in the project documentation.

AVP-103 : Audio/Video Sync	Verify that the audio/video synchronization is maintained to ensure the proper time alignment of signals during playback at the point of user experience or transmission as defined in the project documentation.
AVP-104 : Radio Frequency Television Distribution	Verify that the radio frequency and satellite intermediate frequency distribution systems provide all services to all endpoints as defined in the project documentation. This verification item shall require a metric to be verified.
AVP-105 : Source Testing	Verify that the signal produced by a source typical of what will be used in normal operation of the system is routed through the system to applicable endpoints and produces the performance as defined in the project documentation.
CABL-100 : Cable Bend Radius	Verify that cables are not bent beyond their minimum bend radius as specified in cable data sheet in order to maintain signal integrity as defined in the project documentation.
CABL-101 : AV Connector Plate Input and Output Labeling	Verify all AV connector plate input and output labeling as defined in the project documentation.
CABL-102 : AV Connector Seating	Verify that all AV connectors are correctly keyed, seated, and latched to respective connection points as defined in the project documentation. Conditions where physical parameters exceed the connector's ability to maintain full seating should be resolved as defined in the project documentation.
CABL-103 : AV Connector Verification	Verify that all cable terminations are made securely and meet the recommendations of the connector and cable manufacturer, published standards, as well as the requirements defined in the project documentation.
CABL-104 : AV Power Cable Management	Verify that all AV equipment power cables are managed as defined in the project documentation. Verify that cables are managed in a uniform and acceptable manner so as not to compromise safety/OEM warranty, AV signal quality and/or future field service.
CABL-105 : AV System Cable Labeling	Verify that all cables are identified by a unique ID as defined in the project documentation. Verify that this unique ID is displayed permanently at both ends of the cable, is legible and is positioned where it can be see without undue disturbance.
CABL-106 : Cable Separation	Verify that both site and rack cables have appropriate separation according to signal type and level as defined in the project documentation.
CABL-107 : Cable Supports	Verify that all cables are supported throughout their lengths as defined in the project documentation.

CABL-108 : Cable Ties	Verify that, where appropriate, cable ties are used to secure the cables, are correctly tensioned, and that the correct type of cable tie is used in the project as defined in the project documentation.
CABL-109 : Cables Bundled by Type	Verify that cables are only bundled together when their construction, signal type and signal level are compatible and will not cause measurable crosstalk or interference between cables.
CABL-110 : Cables Dressed	Verify that cables are dressed to ensure that all rack and site cables are installed to provide serviceability, safety and aesthetics as defined in the project documentation.
CABL-111 : Patch Panel Configuration	Verify that all patch panels have been correctly wired and configured as defined in the project documentation.
CABL-112 : Patch Panel Labeling	Verify that all patch panels have been labeled as defined in the project documentation. Verify that all labeling is machine-printed, consistent, durable, accurate, and legible.
CABL-113 : Termination Stress	Verify that all cable terminations have been completely and adequately supported so as to minimize stress on the termination point and/or connector.
CABL-114 : AV Connector Plate Consistent Labeling	Verify that AV connector plates have consistent labeling throughout the project as defined in the project documentation.
CABL-115 : AV System Cabling Verification	Verify that all cabling is of the correct type and routed correctly from point to point as defined in the project documentation.
CABL-116 : Cable Length Required for Serviceability	Verify that sufficient cabling is available so the device can be placed in a serviceable location as defined in the project documentation.
CON-100 : Control Systems Communications	Verify that all control communications are tested from endpoint to endpoint via the appropriate midpoints for operation and functionality as defined in the project documentation.
CON-101 : Control System Interfaces	Verify that AV Control system interfaces to and from control systems provided by others conform to requirements as defined in the project documentation.
CON-102 : Mobile Device Integration	Verify that mobile devices that are to be supported are integrated and operating as defined in the project documentation.

CON-103 : System Response to Emergency Condition(s)	Verify that any required response of the installed AV systems in the event of a life safety or similar emergency operates in accordance with local regulations and as defined in the project documentation. This item specifically excludes sound system response to an emergency condition, which is covered under item AP-100 Emergency Muting.
CON-104 : Control System Automated Functions	Verify that all time-dependent or automated functions executed by the control system conform to requirements as defined in project documentation
CON-105 : Control System User Interface Performance	Verify that the control system is implemented in a manner consistent with the requirements as defined in the project documentation.
CON-106 : Control System Response Time	Verify that the control system provides the user response time and maximum latency defined in the project documentation.
DOC-100 : Final Inventory of AV Equipment	Verify that all equipment as defined in the project documentation has been delivered.
DOC-101 : Approval of Samples	Verify that samples of all equipment to be used as defined in the project documentation have been submitted for approval.
DOC-102 : Delivered Product Against Samples	Where samples of products have been required for approval, verify that the products that are delivered are the same and of the same quality.
DOC-103 : Wireless Frequency Licensing	Where samples of products have been required for approval, verify that the products that are delivered are the same and of the same quality.
DOC-104 : Consultant's Testing	Verify that any consultant's testing requirements defined in the project documentation have been performed and approved.
DOC-105 : General Contractor's Testing	Verify that any general contractor's testing requirements defined in the project documentation have been performed and approved
DOC-106 : Integrator's Testing	Verify that any integrator's testing requirements have been performed and approved as defined in the project documentation.
DOC-107 : Manufacturer's Testing	Verify that any manufacturer's testing requirements defined in the project documentation have been performed and approved.
DOC-108 : Owner's Testing	Verify that any owner's testing requirements defined in the project documentation have been performed and approved.
DOC-109 : Third-Party Testing	Verify that any third-party testing requirements have been performed and approved as defined in the project documentation.

DOC-110 : Substantial/Practical Completion	Verify that a conditional acceptance of the project has been issued by the owner or owner's representative, acknowledging that the project or a designated portion is substantially/practically complete and ready for use by the owner; however, some requirements and/or deliverables defined in the project documentation may not be complete.
DOC-111 : As-Built Drawings Complete	Verify that a complete set of accurate as-built drawings indicating all AV devices, AV device locations, mounting details, system wiring and cabling interconnects and all other details has been provided as defined in the project documentation.
DOC-112 : Audio System Test Reporting	Verify that the audio system test report has been completed and issued as defined in the project documentation.
DOC-113 : Control System Test Report	Verify that the control system test report has been completed and issued as defined in the project documentation.
DOC-114 : Final Commissioning and System Turnover	Verify that the final commissioning report has been completed, issued to the proper entity, and accepted as defined in the project documentation.
DOC-115 : Required Closeout Documentation	Verify that a complete set of as-built system documentation has been provided as defined in the project documentation.
DOC-116 : Software Licensing	Verify that the usage and ownership rights have been assigned as defined in the project documentation.
DOC-117 : User Manuals	Verify that manufacturer's user manuals are delivered to the owner in a format defined in the project documentation (binders, PDFs, etc.) or disposed of in a responsible manner (recycling), if the owner specifies that they do not wish to receive the manuals.
DOC-118 : Video System Test Reporting	Verify that the video system test report has been completed and issued as defined in the project documentation.
DOC-119 : Warranties	Verify that all warranties are activated and that all warranty details have been passed to the owner as defined in the project documentation.
DOC-120 : Final Acceptance	Verify that a final acceptance of the project has been issued by the owner or owner's representative, acknowledging that the project is 100% complete and all required deliverables, services, verification lists, testing, verification, and signoffs have been received, and all requirements defined in the project documentation have been satisfied and completed.

ELEC-100 : AV Equipment Connected to Proper Circuit	Verify that all AV equipment is powered from the designated power circuit and outlet as defined in the project documentation. No additional (non-AV) equipment should be connected unless permitted in the project documentation.
ELEC-101 : Grounding/Earthing	Verify that all elements of the AV system are correctly bonded to an electrical ground/earth in accordance with the requirements of the regulatory authority and as defined in the project documentation.
ELEC-102 : Mains Voltage Sub-Distribution Integrity	Verify that all electrical sub-distribution systems provided by the AV contractor in equipment racks, furniture, and similar structures meet local regulatory requirements for electrical integrity.
ELEC-103 : Power Sources	Verify that the sources of mains voltage AC power to be used for the supply of AV equipment are correct as defined in the project documentation and have been tested to the outlet in accordance with local electrical standards.
ELEC-104 : Power Sequencing	Verify that the power sequencing of devices is correct as defined in the project documentation.
ELEC-105 : UPS Operation	Verify that the uninterruptible power supply (UPS) is performing to the specifications as defined in the project documentation.
ELEC-106 : DC Power Distribution	Verify that all DC-powered devices are receiving the proper voltage and current for normal operation.
ELEC-107 : Power Loss Recovery	Verify that the AV systems resume normal operation on the restoration of power following a hard electrical power outage. Power loss recovery shall include verification of the resumption state on power recovery.
ELEC-108 : Power Monitoring	Verify power-monitoring equipment is working and reporting as defined in the project documentation. Power-monitoring equipment should be verified with a known electrical load where possible. If power-monitoring data is being collected for an energy management system, connectivity with the system should be verified.
IT-100 : Content Delivery Network	Verify that the content delivery network (e.g. Digital Signage) is in place and provides the required connectivity for the required audio, video and control systems.
IT-101 : IEEE 80X Wireless Security	Verify that the wireless network is protected in accordance with the client/owner's information security policies from unauthorized access and provides the required connectivity for the audio, video, and control systems.

IT-102 : Network Bandwidth	Verify that the required network bandwidth is available for control, audio, video, and data as part of either a shared or a dedicated AV network.
IT-103 : 103 Network QoS (Quality of Service)	Verify that the required Quality of Service (QoS) is in place for audio, video, and data as part of either a shared network or a dedicated AV network.
IT-104 : Network Security	Verify that the shared or dedicated network is secure as defined in the project documentation and accessible to suit the required audio, video, and control systems.
IT-105 : Telephony	Verify that any required telephony connections to the AV system are in place and connectivity is verified.
IT-106 : Unified Communications	Verify that any connections to the IT-based unified communication applications that will interface with the AV system have been planned for and integrated.
IT-107 : AV IP Address Scheme	Verify and document that all network-connected equipment has the correct IP address, subnet mask, hostname and gateway configuration as defined in the project scope.
IT-108 : IEEE 802 Wireless Networks	Verify that the wireless network configuration is correct and valid (e.g., channel number, SSID, TX power) in defined areas of use as defined in the project documentation.
IT-109 : PoE	Verify that PoE (Power over Ethernet) devices are supplied with correct power required for normal device operation. Verify under practical conditions that the switch providing PoE had the capacity to power all of the device that are connected to it.
IT-110 : Network Topology	Verify that the network for audio, video, and control is of a suitable topology to support the services to be delivered as defined in the project documentation.
IT-111 : Application Integration	Verify that the AV and control systems have been integrated and have been fully configured wit headend software, including monitoring and asset management; databases; web-based front ends; digital signage software and systems; content generation and distribution platforms; and appliances as defined in the project documentation.
IT-112 : Enterprise Management Tools	Verify that enterprise management tools such as central monitoring client/server or web-based applications have been installed and connected to all systems they are required to monitor or control as specified in the project documentation.

IT-113 : Identity Management Plan	Verify that all systems authentication credentials are configured correctly. Any temporary credentials used during system installation and commissioning should be removed.
IT-114 : Network Performance Under Full Functional Load	Verify that the network can provide the required operational performance to carry control, audio, video, and data under production load and at times of peak production load (refer to IT-10X Network Bandwidth).
IT-115 : Remote Access	Verify that remote access to AV and IT systems is configured as defined in the project documentation.
IT-116 : Remote Management	Verify that remote management tools such as virtual touch-panels, internal web applications, or manufacturer's applications are configured and functional as required by the project documentation and/or manufacturer's specification.
OP-100 : Software	Verify that all control programming code, DSP configuration files and any other associated software have been provided as defined in the project documentation.
OP-101 : Battery Management Plan	Verify that a battery management plan has been completed and supplied in the project documentation package to owner.
OP-102 : Content Management Plan	Verify there is a plan for managing the content to be delivered by the AV systems, including the means to create content and update content when new information needs to be conveyed.
OP-103 : System Content Provided	Verify that any owner, vendor, or third-party-produced system content that is required for operations as defined in the project documentation has been supplied, loaded, and tested in the completed AV system.
PHYSE-100 : Divisible Spaces	Verify that divisible spaces provide the functionality specified as defined in the project documentation.
PHYSE-101 : Human Factors, Usability, and Ergonomics	Verify that ergonomics and usability elements for audience and system users are installed and configured as defined in the project documentation.
PHYSE-102 : Lighting	Verify that the lighting systems are suitable for each type of application (e.g., videoconferencing, presentation, broadcast, performance) as defined in the project documentation.
PHYSE-103 : Vibration	Verify that the physical environment is suitable for the intended AV systems in relation to all sources of vibration affecting stability of equipment such as videoconferencing cameras, document cameras, and fixed screen and projector locations.

PHYSE-104 : Backing/Blocking/Framing	Verify that installed backing, blocking and framing meets project documentation requirements and industry standards for installation means and methods.
PHYSE-105 : Clean Building Handover	Verify that the area is clean and dust-free and suitable for equipment installation and that no further work is planned that will release contaminants into the AV equipment area. Verify that the area released is isolated from any areas not yet released.
PHYSE-106 : Coordinated Construction Elements	Verify that the elements including but not limited to spatial requirements and building services required by the AV system that are coordinated with other disciplines have been provided per the project documentation.
PHYSE-107 : Device Enclosures	Verify that device enclosures accommodate the intended device and that all necessary environmental controls (e.g., heating, cooling, humidity) are incorporated into the enclosure as defined in the project documentation.
PHYSE-108 : Finishes	Verify AV equipment, furniture, fixtures and accessories against the project documentation.
PHYSE-109 : Floor Boxes/Wall Boxes/Ceiling Boxes	Verify that installed floor, wall and ceiling boxes meet project documentation and regulatory authority requirements.
PHYSE-110 : HVAC Commissioned	Verify that the HVAC system has been tested and balanced prior to completing verification items AP-11X Acoustical Ambient Noise and AP-116 Audio Level Exceeds Background Noise Level.
PHYSE-111 : HVAC Operation	Verify that the HVAC system has begun continuous operations in advance of equipment operations.
PHYSE-112 : Structural Mounting	Verify configuration and compatibility of structural accommodations and all mounting hardware based on the intended application. All equipment mounting hardware shall be installed in the manner specified by the hardware manufacturer.
PHYSE-113 : Protection of Installed Equipment	Verify that all elements of the AV system are free of damage.
PHYSE-114 : Accessibility	Verify that all systems are accessible in accordance with regulatory requirements.
PHYSI-100 : Cable Containment/Conduit	Verify that installed containment/conduit capacity and routes meet project documentation requirements, industry standards and regulatory requirements for installation means and methods.

PHYSI-101 : AV Rack Air Flow and Temperature Performance	Verify that the AV racks provide the airflow as required in the project documentation. Verify that the temperature in the AV rack has been measured and is within tolerances defined by manufacturers guidelines and the project documentation.
PHYSI-102 : Equipment Security	Verify that equipment is secured as defined in the project documentation. Verify that all security systems, devices, and manufacturer security accessories are installed and verified to be operating as defined in project documentation.
PHYSI-103 : Equipment Labeling	Verify that all AV equipment has been labeled in accordance with the requirements of the project documentation. All labeling must be consistent, durable, accurate and visible without dismantling of sub-assemblies.
PHYSI-104 : Plumb and Level/Square	Verify that all AV equipment has been installed, aligned, or angled correctly as defined in the project documentation. Level and plumb are the default requirement unless particular angles or other alignments are defined in the project documentation.
PHYSI-105 : Site Security	Verify that all elements of the AV system are free from loss, damage or tampering.
PHYSI-106 : AV Equipment Located Per Project Documentation	Verify that AV equipment is installed at the location and/or in the rack or enclosure as defined in the project documentation. Equipment is installed per the elevation or other specification provided by the project documentation or the manufacturer's specification.
PHYSI-107 : AV Rack Cleanliness	Verify that all components installed in AV equipment racks are free from dirt, dust, water, or any other element that would compromise the performance and/or longevity of the AV system.
PHYSI-108 : Non-End-User Controls Protection	Verify that installed items with user-facing controls that are not intended for end-user access have been covered, disabled, or otherwise secured to prevent end-user operation.
PHYSI-109 : Optical Components Cleanliness	Verify that all optical components, such as lenses and mirrors, are free from dirt, dust, damage, or markings that would compromise the optical performance of those system components.
PHYSI-110 : Handling of Accessories Otherwise Undefined	Verify that all items that may have been pre-packaged with primary system equipment but which have no documented planned use in the AV system(s) are managed in accordance with the project documentation.

PHYSI-111 : Turnover of Accessory System Elements	Verify that any equipment that may be considered "portable" and/or otherwise not specifically incorporated into the installed AV system(s) has been set up, configured, and tested.
SERV-100 : Access Panels	Verify that any access panels that have been installed to provide access to any type of AV equipment are properly sized and positioned as detailed in the project documentation.
SERV-101 : Ability to Maintain and Service Equipment	All equipment shall be accessible and capable of being maintained, serviced, cleaned or adjusted as necessary. All equipment requiring regular cleaning or maintenance shall be accessible without requirement for special equipment or tools that would disrupt the normal use of the facility and systems therein.
SERV-102 : Input and Output Panel Accessibility	Verify that all input and output panels are accessible and meet all requirements for user access and placement.
SERV-103 : Rack Clearance	Verify rack placement and use for physical stability in accordance with the project documentation and regulatory authority.
WL-100 : Wireless Audio Systems Operation	Verify that the operation of wireless audio systems (RF and IR) is as defined in the project documentation.
WL-101 : Wireless Control Systems Operation	Verify that the operation of wireless control systems (RF and IR) is as defined in the project documentation.
WL-102 : Wireless Coordination	Verify that the environment is suitable for the required wireless services (RF and IR) to provide audio, video, and control, and can be implemented for the required number of channels as defined in the project documentation.
WL-103 : Wireless Video Systems Operation	Verify that the operation of wireless video systems (RF and IR) is as defined in the project documentation.
SSR-100	Verify that the Room Scheduling panel is securely installed and is plumb/level. Verify that it's joined to server and is reservable through Outlook or directly through the panel itself.

SECTION 28 00 00 - SECURITY ACCESS AND SURVEILLANCE

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

A. General

1. In accordance with the contract documents provide all material, labor, equipment and services necessary to furnish, install, commission, warrant and maintain the Security System (SS). The intent of this document is to provide the design specification for furnishing systems as described below.

2. Security contractor shall provide unit pricing for all security devices. The security system shall include the following:

3. CCTV System

a. Surveillance cameras with lenses

(i) IP Fixed Cameras

(ii) IP Pan/Tilt/Zoom (PTZ) cameras

b. Housings and mounts

c. Network Video Recorders

d. System Software

e. PC Workstations

4. Access Control System (ACS)

a. Card Readers

b. File Server

c. Security Workstations

d. Controller Panels

e. Access cards

f. Power Supplies

5. Cables and Termination Equipment

a. CAT 6 Cables

b. CAT 6 Patch Panels

c. Copper Cables

6. Video Intercom

a. Door Station

b. Master Station

7. Network Switches

8. Equipment Cabinets

9. UPS

1.2 QUALIFICATIONS

A. The contractor for the security system specified shall have the following qualifications and bidders shall submit documentary evidence of same with bid proposal:

1. Existence at time of bidding of a local office near the project site, with a staff of factory trained engineers and technicians who are qualified to provide instructions, routine and emergency maintenance and repairs on all portions of systems. Service staff shall be available for emergency service on a 24-hour basis. Service escalation policies must be submitted at time of bid.

2. A minimum of 10 years of experience in successful design, installation service and operation of CCTV System and computer based security systems similar to the systems and sub-systems specified.

3. The Contractor performing the Work of this Section must, within the last five (5) consecutive years, have successfully completed in a timely fashion at least three (3) projects similar in scope and type to the required work for this Section.

4. The Contractor performing the Work of this Section may demonstrate compliance with the above qualification requirements by demonstrating that it is certified or authorized as an installer by a manufacturer designated as acceptable in these Specifications.

5. A copy of such manufacturer certification or authorization must be submitted, or verified in writing by the manufacturer.

6. Evidence that the design, manufacture and testing of the components of the systems and sub-systems that are not manufactured by the supplier shall be in accordance with the specifications.

1.3 SUBMITTALS

A. Submittals, approvals and documentation deliverables.

1. Prior to the start of installation, security contractor shall submit the following for approval:

   a. General description of operation.

   b. Technical specification data sheets for all items included in this specification.

   c. Samples of all exposed equipment and mounting hardware.

   d. Shop drawings showing wiring diagrams, installation and mounting methods and details, point-to-point termination schedules. All drawings shall be fully dimensioned.

2. Prior to start of testing, submit for approval the methodology for factory and site testing to be used including sample data sheets.

3. Prior to start of training, submit syllabus and course outline for approval. Coordinate with security department for scheduling.

4. System documentation: System documentation is required and shall contain at a minimum, the following items:

   a. Operating manual (3 copies).

   b. Maintenance manual (3 copies).

   c. Project Progress reports (30%, 50%, 90%, 100% completion).

   d. Record drawings: ASBUILT and As Approved (One (1) reproducible drawing) including wiring diagrams and point-to-point terminations. All correlative notations on the shop drawings shall also be incorporated along with all field installation variations.

5. The as-built drawings shall be produced using AutoCAD 2010 design package. Provide one (1) set of drawings in electronic format on CD.

6. The quantity of design drawings which are made available shall in no way be interpreted as setting a limit to the number of drawings necessary to show the required “as-built” information.

7. Any and all costs for document conversion (if necessary), printing, etc. are the responsibility of the contractor.

8. Design drawings in electronic format will be made available on AutoCAD, 2008, for the exclusive purpose of producing "as-built" drawings. These documents remain the property of Cosentini Associates and shall be used for no other purpose without expressed written consent. The contractor shall assume all liabilities resulting from unauthorized modifications to the drawings.

9. Prior to developing any "as-built" drawings, the contractor shall coordinate with the Owner and Engineer the layering structure, colors, etc. of all CAD drawings.

10. "As-built" information submitted to the engineer for approval shall contain the following:

    a. CAD drawings files on CD ROM.

    b. One (1) reproducible drawing.

    c. Two (2) prints.

B. Computer system documentation (3 copies). Include configuration diagrams, as-built capacities, field expansion capabilities, operating system and software configuration. Include fully documented application software manual(s).

1.4 SUSTAINABLE DESIGN REQUIREMENTS

A. Related Sustainable Design Sections:

1. 018113 – Sustainable Design Requirements

    a. 018113.1 LEED version 4 Complaint Material Matrix

B. Submittals

1. This section includes LEED Building Products (LBP) which contribute to LEED credit for Building Product Disclosure and Optimization. The product that is ultimately purchased and installed must be exactly as listed below in manufacturer, make/model, product type and all selected features without exception. Any "Substitution for Cause" submission must meet the requirements detailed in spec section 01 25 00 Substitution Procedures. This product shall not be considered for "Substitution for Convenience".

    a. Card Reader. Manufacturer HID. Model RP40.

2. For products described in Specification 018113 Section 1.O, provide Material Safety Data Sheet (MSDS) or letter from manufacturer certifying the VOC content for each adhesive, sealant, paint and coating, flooring, and composite wood product does not exceed the maximum VOC threshold based on application.

3. Where new wood products are used and will be permanently installed inside the building, provide vendor invoices for each new wood product that has been harvested in accordance with the FSC standards. Invoices shall include chain-of-custody, certificate numbers, and itemized costs for all certified products

1.5 PARTS REPLACEMENT

A. Replacement Parts

1. The bidder shall maintain a replacement parts department and provide test equipment when needed. A complete parts depot shall be located in a geographical proximity consistent with the most expedient method of shipping replacement parts. An ample stock of individual components and equivalent unit replacements shall be carried for as long a period as demand warrants. This period shall extend well beyond the normal life expectancy of the equipment. Test equipment and tools shall be provided, that is, designed, tested, and qualified to meet the needs of the product servicing. Calibration service shall be available on all test instruments.

2. Refer to Section 3.01 for Maintenance Data and Operating Instructions.

1.6 WARRANTY

A. Security contractor shall warrant the installed system to be free of defects of materials and workmanship for a period of one (1) year following system acceptance by Owner and Engineer. System acceptance will commence when all parts, components, sub-systems and systems have been tested and shown to be working in accordance with the specification.

1. During the guarantee period provide 24-hour service seven days a week.

2. Service shall be rendered within 4 hours of notification of a problem.

3. Servicing to include following:

a. Emergency maintenance service (24 hr.).

b. Replacing defective parts and components as required.

c. Service by factory trained service representative of system manufacturers.

d. Maintenance of system programming.

e. Incorporate items to improve system reliability as they become available. Direct equipment replacement and wiring changes will be made only after approval by authorized representative. Not to include major system design changes.

f. Regularly scheduled preventive maintenance: submit schedule of tasks and frequency of performance prior to acceptance.

g. Periodic maintenance reports to authorized representative documenting routing and emergency maintenance procedures performed. Include detailed description of symptoms, diagnosis and subsequent action taken for emergency maintenance. Include changes in routine maintenance procedures.

1.7 TRAINING

A. Security contractor shall train a minimum of 2 operators for system operation. Each operator shall be trained for a total of 12 hrs. each. The instruction shall be provided by an engineer representing the contractor.

1. Provide each operator with complete, printed operating instructions and brief sub-system description in manual or handbook form.

2. The Owner shall be trained in preventive maintenance for all CCTV and auxiliary systems.

3. Certification of operators shall be provided upon the completion of training

4. The Owner shall be notified if personnel assigned to training should not be certified.

1.8 TECHNICAL PROPOSAL

A. All bidders shall submit, at the time of bid, a technical proposal describing methods to meet the performance requirements of specification. Information that the bidder considers relevant should be included. This proposal will be used to evaluate the qualifications of bidder.

1. The proposal shall describe the entire SS, including the central and the remote equipment required for the specified systems operation. Include the descriptions of hardware, software and the systems engineering considerations. Highlight items considered advantageous, as well as the unspecified standard system features to be provided.

2. Software shall be a standard, proven product. If customization is required, bidder shall describe procedures for the software development from conception to implementation. This shall include, but not limited to:

a. Schedule for program development.

b. Schedule for bringing programs on line and debugging.

c. Documentation standards.

d. Description of bidder responsibility and that of any lower tier contractor.

e. Reference of at least 3 other similar software installations.

B. Technical proposal shall also include the following:

1. General overview of corporate SS capabilities.

2. Local experience, installation and service capabilities of SS contractor and system manufacturer.

3. Technical description of the system as understood by the bidder.

4. Methods of related sub-system integration.

5. System hardware and software macro-architecture.

6. Equipment approvals, by independent testing laboratories, listings, adherence to code.

7. Description of system flexibility, future expansion capability, expansion methods.

8. Conformance and exception section describing the applicability of the proposed system to these specifications.

9. Construction schedule from contract award to completion of acceptance testing (Time line table).

10. Description of any site space or support facilities required during construction.

11. Details of any changes to wire and cable details required by bidder's system.

1.9 RESPONSIBILITIES OF SS CONTRACTOR

A. Electrical contractor shall supply 110VAC electrical power in the locations shown on security drawings.

B. Security contractor to make final connection to the power supplies and control panels.

C. Security contractor shall be responsible for providing the 24VAC/DC power source for all security equipment/devices.

D. Security contractor shall be responsible for coordinating the security system's space requirements, location and layout within the Security office, and telecom closets.

E. Contractor shall coordinate with elevator contractor for cameras and card readers installation inside the elevator cars and for traveling cable.

F. Contractor shall coordinate with door hardware provider for door hardware types and model.

1.10 DELIVERY, STORAGE AND HANDLING

A. Costs of all shipping to the site, and of all unusual storage requirements, shall be borne by the Contractor. It shall be the responsibility of the Contractor to make appropriate arrangements and to coordinate with authorized personnel at the site for the proper acceptance, handling, protection, and storage of equipment so delivered.

B. Movement of material, either at the time of delivery or subsequently, shall be the sole responsibility of the contractor. All costs associated with this movement shall also be the responsibility of the contractor.

C. The Contractor shall be responsible for the safe storage of all equipment. In the event of equipment disappearance from the site, the Contractor shall bear full responsibility for all costs associated with equipment replacement at no additional cost to the Owner or their representatives.

1.11 QUALITY ASSURANCE

A. All equipment provided by the contractor shall be new and shall meet or exceed the latest published specifications of the manufacturer in all respects.

B. Contractor to provide the latest model/revision of a specified piece of equipment, at the time of bid.

C. Obtain detailed instructions for installation from manufacturer of each product.

1.12 SEQUENCING AND SCHEDULING

A. Prior to installation of any equipment, Security contractor shall advise and coordinate with Owner's representative.

B. Security contractor shall provide a schedule listing of activities including employee allocation and material procurement that demonstrates the plan to meet the construction schedule. This schedule shall include the number of employees to be assigned and duration required for each phase. After award of the contract, the schedule shall be updated to show any operational conflicts that shall be coordinated and approved by the Owner's representative before implementation.

1.13 PARTIAL LIST OF RECOMMENDED EQUIPMENT MANUFACTURERS

A. CCTV System

1. Axis, Samsung, Vivotek, (Cameras)

2. Genetec, Exaq, Milestone (Video Management System, Recording)

3. BCD Video, Seneca, HP, Dell (network video recording hardware)

B. Access Control/Alarm Monitoring

1. Software House, (Hardware & Software) or approved equal.

2. Alarm Monitoring (GE Security, Bosch)

C. Aiphone, Siedle, Comelit (Video Intercom)

D. Winsted, Middle Atlantic (Consoles, Racks)

E. NEC, Samsung, Panasonic (Monitors)

1.14 UNIT PRICE QUOTATIONS

A. Submit separate unit price quotations for each of the various items hereinafter specified, using the attached "Bid Response Form." Unit prices shall include overhead, profit, insurance and taxes.

B. Unit price quotations shall be suitable both for additions and deductions.

C. Except where specific exceptions are indicated, it shall be understood that equipment, materials, installation methods, etc., required for unit quotation items are to be identical to those called for under the base bid.

D. Unit price quotations shall, in each case, be for complete work, furnished and installed, unless otherwise noted.

PART 2 - PRODUCTS

2.1 GENERAL

A. This document outlines the requirements for an integrated Security Management System for the premises detailed in the request for quotation letter.

B. The specification represents both current and future needs. All submissions must clearly indicate any inability to fully comply with the requirements as detailed in this document.

C. Scope of Work

1. The quotation is to include for the supply, installation, and commissioning of the system as specified.

2. The attached schedules provide details of all locations where security devices are to be included for this quotation.

3. The Installer shall identify all equipment locations requiring an electrical supply outlet. Emergency power shall be provided by others to a junction box at each location shown on security drawings.

4. Security Contractor shall provide final power connections from junction boxes to the security panels, devices, equipment, etc.

5. Security Contractor shall ground security equipment as required by Code. Telecommunication Grounding system or building steel shall be used.

6. Provision of electrical services being excluded from this quotation.

D. Materials

1. Wire (see riser diagram drawings)

a. Provide wire in accordance with security drawings

2. Identification and Tagging

a. All cables, wires, terminal blocks and terminals shall be identified by labels, tags or other permanent markings.

b. All markings shall clearly indicate the function, source and destination, polyolefin of each wire. Use wire markers for each wire.

c. All terminal points shall be appropriately labeled.

2.2 SECURITY MANAGEMENT SYSTEM EQUIPMENT/MATERIALS

A. Security Software

1. Security applications software shall be a standard off-the-shelf product of the Security System manufacturer and shall be supplied complete with necessary user license(s) and manufacturer's documentation.

2. Security System contractor shall be responsible for all modifications and programming of the security software, including any interface with existing database(s).

3. All data retrieval and transfers with existing databases shall be on line in real time.

B. Security Hardware

1. System and system equipment shall be listed, labeled or approved by applicable standards of Underwriters Laboratories, Inc.

2. Equipment Enclosures

a. All enclosures for equipment supplied under this specification shall be lockable and protected against tampering by being equipped with tamper switches or triggering mechanisms electrically compatible with the alarm system.

b. All controls, which affect the sensitivity of the units, shall be located inside the tamper resistant enclosure.

c. Keylocks or key operated switches used to protect enclosures shall have Underwriter's Laboratories listed locking cylinders.

C. Security Systems Power Requirements

1. Refer to security drawings for locations of the electrical junction boxes and receptacles, number and size of the electrical circuits.

D. Cables, Cable Management/Support Hardware

1. CAT 6 Cables

a. The installation procedures, methods and conditions shall comply with the latest requirements of the Federal Occupational Safety and Health Administration (OSHA).

b. All cable installations shall be in conformance with the latest revisions of ANSI/TIA/EIA-568-B, 569-A, 606 and 607, as well as all associated addendums and telecommunications systems bulletins (TSB's).

c. The horizontal wiring system shall run from each camera or workstation outlet to the security or telecommunication room.

d. The maximum horizontal distance from the security or telecommunication room, where cables are terminated to the camera or workstation outlets shall be 90 meters (295 feet) independent of media type. An additional 6 meters (20 feet) is allowed for patch cables at the security or telecommunication room and at the workstation, but the combined length cannot exceed 10 meters (33 feet).The horizontal cable shall be four-pair 100-ohm UTP CAT6 cable.

2. CAT6 Patch Panel

a. UTP Patch Panel shall meet or exceed Category 6 and ISO 11801 2nd Edition Class E standards.

b. The unit shall be of recessed design with lower mounted profile.

c. Each port shall be 100% tested to ensure NEXT and RL performance.

d. Category 6 Patch Panel shall utilize 110 punch down termination on back panel and include retention cap to each port.

e. Each port shall contain a universal label that is color coded for T568A and T568B wiring schemes.

f. Category 6 Patch Panel shall be designed for the termination of 4-pair, 22-26 AWG, 100ohm, solid or stranded twisted pair cable. Category 6 Patch Panel shall be mounted to the standard EIA 19" rack.

g. Label kits shall contain adhesive label holders and labels for easy port and panel identification.

h. Manufacturer: Ortronics. Model No. OR-PHA66U24 or approved equal

3. Cable Tray

a. Shall be a steel, channel type cable runway for overhead cable support in Security Command Center.

b. Tubular side bars, 225mm rung spacing, 37mm x 10mm stringers, 12mm X 25mm cross members, 300mm, 375 mm, 450mm widths as indicated on Drawings.

c. Shall be UL Classified.

d. Shall be completed with cable retaining posts and all necessary supports, hangers, connectors, junction and splice kits, wall angles, nuts, bolts, etc. necessary for a complete installation.

e. Manufacturer: Chatsworth, B-Line, Newton. Catalog No.'s.: 11275-012/015/018 or approved equal

4. Cable manager.

a. For support of cross connect and patch cordage on equipment frames/racks.

b. Manufacturer: The Siemon Company, Ortronics, Avaya. Part No. S110-RWM-2DS or approved equivalent

5. Polyethylene spiral cable wrapping.

a. To manage and protect exposed cable bundles. As required. 3/8" Black

b. Manufacturer: Panduit. Part No. T-50 or approved equivalent

6. Labels

a. Labels shall be self adhesive, self-laminating, with white matte finish printing area, clear plastic shield. Pin feed for machine printing.

b. Shall be used for cable identification.

c. Labels shall be provided on both ends of all cables. 25mm width for horizontal cabling, 50mm width for riser cabling. Length as required for other cable media

d. Manufacturer: W. H. Brady Co. Length as required for other cable media or approved equivalent

e. Labels. White Polyester. Laser printable for use on patch panels. 20mm x 6mm, 25mm x 12mm.

(1) Manufacturer: W. H. Brady Co. Part Number: CL-041-619 (20mm x6mm) or approved equivalent

f. Labels. White polyester. Laser printable. Used for cable ladders, racks, frames, etc., as required.

(1) Manufacturer: W. H. Brady Co. Part Number: BCDAT-2-619 or approved equivalent

(2) Labels. Paper label inserts for 110 blocks. Utilize EIA 606 compliant colors.

(a) Manufacturer: W. H. Brady Co.

(b) Part Number:DATA-177-124-BL - Blue - Horizontal Cables

(c) Part Number:DATA-177-124-WT - White - Riser cables Part Number:DATA-177-124-GY - Gray - Tie cables

(d) Part Number:DATA-177-124-YL -Yellow - Misc. riser Or approved equivalent.

E. Grounding Equipment

1. Bus bar Kit

a. Shall be wall mounted. Predrilled, solid copper Ground Bar with insulated stand off brackets.

b. The size shall be 20mm x 100mm x 500mm in Security Command Center

c. Manufacturer: Chatsworth, Newton, B-Line, Erico. Part No.10622-020 or approved equivalent.

F. Equipment Cabinet

1. The unit shall be of steel superstructure stand alone framework.

2. The unit shall include EIA standard 500mm rack frame, pedestal, side panels, vented top panel, rack mount 6 fan cabinet blower, lockable rear door, lockable Plexiglas front door, keyboard pull-out shelf and other shelves as required.

3. All welds shall be filed smooth and sharp corners blended.

4. All metal work shall be free of rust and degreased prior to application of primer paint.

5. All cabling shall be neatly installed, tagged and identified. Termination strips shall be clearly labeled.

6. Sufficient rack space shall be provided for expansion up to 20% design space.

7. Manufacturer: Winsted or approved equal. See security drawings for model numbers.

G. Uninterruptible Power Supply (UPS)

1. The unit shall be uninterruptible power supply designed for rack mounting in a standard 19" EIA rack mount assembly and tower, where required.

2. Output power capacity shall be 2100 Watts/3000 VA.

3. The unit shall include (2) battery modules with typical recharge time 2.5 hours.

4. The run time shall be 34.3 minutes at half load and 9.7 minutes at full load.

5. The unit shall include RS232 Interface port.

6. The unit shall support following features: Automatic Self Test, Automatic Voltage Regulation (AVR), Hot Swap Batteries, Intelligent Battery Manager, Network Grade line conditioner, Overload Indicator, Replace Batt Indicator, Scalable Run Time, User Replaceable batteries.

7. Input: 120 VAC 50/60 Hz, NEMA L5-30P.

8. Output: Total of (8) 120 VAC outputs: (6) NEMA 5-15R, (2) NEMA 5-20R

9. The unit shall include surge protection and filtering.

10. Operating environment: 32-104°F,

11. The unit shall comply with CSA, FCC A, UL 1778.

12. Manufacturer: APC. Model No.: SURTA3000RMXL3U or approved equal.

2.3 CLOSED CIRCUIT TELEVISION SYSTEM

A. Network Video Recorder (NVR) Hardware Platform

1. The Network Video Recorder, a device for recording IP based video from IP output cameras or analog cameras that have been converted to IP output, shall consist of a PC Compatible Chassis and other specified components, as shown in the following sub sections that together create the Network Video Recorder.

B. Recording Server shall meet the following specifications:

1. Dimensions: 3.4"H (2RU) x 17.08"W (19" rack) x 27.31"D.

2. CPU – Intel Xeon Silver 4210 Scalable Processor

3. RAM – minimum of 32 GB

4. Network – Gigabit Ethernet connection. Quantity 2 and (2) 10GbE SFP+ ports.

5. Graphic Adapter – PCI, AGP, PCI-Express, minimum 1280 x 1024, 16 bit color

6. Hard Disk Type – E-IDI, PATA, SATA, SCSI, SAS (7200 RPM or faster)

7. Operating System – Windows Server 2019.

8. Video drives shall be 8 x 8TB 3.5" SATA II hot-swap, RAID 6, usable capacity – 32 TB.

9. Power – Redundant power supply, 120 VAC, 1100 watt.

10. Heat Dissipation - 4100 BTU's

11. Front: 2 x USB 2.0 and 1 x DRAC, Micro-AB port, Rear: 2 x USB 3.0 ports.

12. Manufacturer: BCD Video. Model: BCD208-PVS (rack mount server) approved equal.

C. Viewer Workstation, Matrix Monitor

1. CPU – Intel 9th Generation Core Processor.

2. RAM – minimum of 64GB DDR4

3. Available Graphic Adapters:

   a. Intel® l UHD630, NVIDIA® Quadro® P400, P620, P1000, P2000, P4000, RTX 4000 GeForce® GTX 1650, GTX 1660, RTX 2060 Super, RTX 2070 Super, RTX 2080 Super.

4. Hard Disk Type – Dedicated NVMe M.2 OS Solid State Drive

5. Dimensions: 6.69"W x 17.12"D x 14.17"H

6. Operating System – Windows 10 Pro.

7. Power – 120 VAC, 435 watt.

8. Manufacturer: BCD Video Model: BCDT03-PWS or approved equal.

D. IP Based Integrated Digital Video Management System (IPDVMS).

1. The SMS shall support an integrated IP Based Digital Video Management recording solution that provides the following features and capabilities:

   a. Seamless integration with the SMS

   b. Stand alone operation without connection to the SMS

   c. The IPDVMS shall be computer hardware independent and must meet or exceed the manufacturer's minimum specification for the computer and related devices.

d. The IPDVMS shall incorporate a modular architecture and be able to support an unlimited number of cameras.

e. The IPDVMS shall be able to simultaneously record and display live video and display recorded video.

f. The IPDVMS shall support both event based and continuous recording.

g. The IPDVMS shall mark all events and they shall be available for playback and or archiving at any time

h. Video events shall be linked to SMS events in the SMS database and only one database shall be acceptable for this interface.

i. Up to 32 simultaneous users shall be able to access any video feed from any recorder on the network.

j. User defined profiles shall be available for tailoring granular access to configuration and operation

k. Shall have the ability to enhance a frame of video with embedded features or off the shelf software while providing security for the original video image to preserve integrity.

l. Shall be capable of independent camera setup for, compression rate, brightness, contrast and other factor setups.

m. The IPDVMS shall support Ethernet 10BT, Ethernet 100BT and 1000BT. Network protocols shall be supported including TCP/IP, IPX, and UDP.

n. The network interface shall allow remote access of the IPDVMS from anywhere on the end-users LAN/WAN.

o. Shall support limiting of frame rate transmission to individual clients.

p. The IPDVMS shall support either Multicast or Unicast streaming technology.

q. The IPDVMS shall be have the ability to playback stored video over the LAN / WAN for remote access of video clips.

r. The IPDVMS shall support World Time Zone.

s. Any alarm / event in the SMS shall have the ability to be associated with a digital video clip in real time. The IPDVMS shall support user defined pre and post roll.

t. Each camera shall be configurable for a 32 alphanumeric character name and shall allow for the setup and adjustment of brightness, contrast, archiving, motion detection, Pan / Tilt / Zoom, on a per camera basis.

u. The IPDVMS shall support CCTV PTZ control via the SMS video interface.

v. The IPDVMS shall support Analog CCTV PTZ control via approved Video Encoding Devices.

w. The IPDVMS shall support MJPEG and MPEG4 formats for multiple IP Video Cameras and IP Video Encoders from approved sources.

x. The IPDVMS shall support integral time stamping upon receipt of video from the camera.

2. The IPDVMS shall support the following configuration and customization parameters:

a. Compression percentage

b. Pre and Post Roll in seconds

c. Motion Detection Alarms

d. Set Time Lapse Recording

e. Continuous Recording Mode

f. The ability to enforce user authentication to specify individuals or groups that have the ability to view live or recorded video or make modifications to the system.

g. The ability to change any or all of the associated IP camera passwords manually or on schedule.

h. User determination of Event Locking method.

i. Dual Path Fail Over support

j. Blind Camera (Obstructed View) Alarm reporting.

k. Presets on Alarm

l. Event Locking to protect specific video events from being overwritten

m. UNC path support for Network Attached Storage Devices

n. Configuration of Off-line cameras

o. Support for Intelligent Motion Video Searching

p. Device Linkages

q. An unlimited number of access control hardware / device links shall be configurable.

r. A camera viewing priority shall be given to each access control hardware device link.

s. Each alarm / event condition shall have the ability to mark the start of a video event or the end of a video event in real time.

t. The IPDVMS shall support uni-directional audio recording utilizing built in audio recording devices on select IP cameras

u. The IPDVMS shall support automatic firmware downloads to select IP cameras.

v. The IPDVMS shall support both internal camera video storage and external camera video storage. Internal storage shall allow the camera to store video events and then download these events to the IPDVMS on a predetermined schedule or on demand

w. Pan / Tilt / Zoom Control from Alarm Monitoring

x. The IPDVMS shall support PTZ control from the Alarm Monitoring workstation. The PTZ control shall support approved IP PTZ cameras and Analog Cameras connected to approved IP Servers.

y. The IPDVMS shall support the following PTZ features:

(1) Priority Levels

(2) Device Group Control

(3) PTZ Override (Lockout)

(4) Proportional PTZ Control

(5) Preset Lock via video screen

(6) Preset Tour

3. Video Archiving

a. The Archive Server software shall be hardware independent, providing the ability to utilize commercial off-the-shelf mass storage devices, including SAN (Storage Area Network) solutions, Tape Libraries, and direct connect external storage drive arrays.

b. The Archive Server software shall provide the ability to manage and store video information from multiple video recorders to a central location, without operational degradation.

c. Each DVMS / IPDVMS shall have the ability to set its own unique archiving properties. Video shall automatically be archived based on user defined "percentage full" settings. When the IPDVMS reaches the designated capacity threshold, video shall be automatically copied to the archive storage media and space on the recorder is released for over-write by new video information.

d. Regardless of the storage location (local on the recorder or in archive) the system will automatically retrieve video associated with an event on demand. The actual storage location shall be transparent to the user.

e. Browser Based Video Viewer

f. The IPDVMS shall allow monitoring of real time video from an optional web browser based video viewer using N-Tier architecture and Microsoft Internet Explorer @ 1024x768 resolution. The browser based viewer shall have the ability to select multiple viewing templates. The browser based viewer shall provide the following functionality:

(1) Display live video

(2) Digital zooming and panning

(3) PTZ camera control

(4) Drag or double click to center

(5) Continuous click to center

(6) Click and hold to move

(7) Ability to access video from multiple recording sources

(8) PTZ locking

(9) Priority based camera control takeover

4. Real Video Time Monitoring

a. The IPDVMS shall allow monitoring of real time video from any Alarm Monitoring client workstation. DVS and Camera status shall be displayed on a System Hardware Tree.

b. Video Viewing Layouts

c. The IPDVMS shall support the ability to save the list of camera views currently being displayed along with the currently selected template with a user defined name to be loaded as needed by the system operator.

5. Video Player

   a. The IPDVMS shall support an advanced matrix view of multiple On-line camera views. Up to a total of 128 fps @ CIF resolution and 72 fps @ 4CIF resolution shall be available for viewing in the Matrix View. The 128 frame rate limitation of video shall be any combination of Live or Recorded video. The number of open video windows shall be dependent on the frame rate and resolution of the cameras. The Video Player shall allow operator sizing of the video windows in the matrix view.

6. Video Camera Groups / Video Camera Tours

   a. The IPDVMS shall support camera grouping to allow for video camera tours in the SMS Alarm Monitoring Module.

   b. An unlimited number of camera groups shall be supported in the SMS and each camera group shall support an unlimited number of cameras. Cameras within a camera group shall span multiple digital video servers. Cameras shall have the ability to be placed into multiple camera groups.

   c. The SMS shall provide for video camera tours that rotate live video between each of the cameras defined in the video camera group at a user defined increment. The time increment shall be user definable in whole seconds.

7. Still Image Capture / Save

   a. During playback or monitoring of video, the System shall have the ability to create and save a still picture. This operation shall not affect any other operation and shall not alter the recorded video. The file format shall be an industry standard format allowing for file transfer via e-mail, printing or file transfer to other media

8. Export Video Clip to File

   a. The SMS shall have to ability to save and export recorded video to a file for the purpose of sharing and reviewing video clips. The start and end times for each video segment shall be user defined. The exported video clip shall be viewable via a standard Windows media player.

9. Video Image Processing

   a. The IPDVMS shall support video image processing of a single frame captured image through use of an integral image processing module which shall offer the following features:

      (1) Intensity, Contrast and Saturation

      (2) Gamma Correct

(3) Histo-Contrast and Histo-Equalize

(4) Flip, Reverse, Invert and Rotate

(5) Shear

(6) Add Noise, Average, Sharpen, Mosaic, Posterize and Median

(7) Halftone

(8) Emboss

(9) Gray Scale

(10) The IPDVMS shall allow the ability to save any combination of effects as a defined profile. Profiles shall have the ability to be added or deleted from the SMS at any time.

10. Video Loss Detection

a. The SMS shall detect video loss from any or all cameras and activate an alarm.

b. Automated Motion Video Searching

c. The IPDVMS shall support advanced automated motion video searching against pre-recorded video. The automated motion video search shall analyze frames in a video segment to detect motion activity from image to image. It shall display thumbnail images of the frames with activity, complete with a histogram depicting the relative amount of activity within each frame.

d. The search shall be defined by selecting a specific camera and a specific time period in which the suspected activity took place and all motion events associated with that camera and time period shall be displayed in either a trace or thumbnail format for review.

11. Remote Monitoring Application

a. The IPDVMS shall support a Remote Monitoring Application that allows the operator to monitor video from any computer connected to the SMS network.

12. Video Authentication

a. The IPDVMS shall support imbedded authentication of video where the video is watermarked with an authentication key/signature during recording of live video to a hard drive. The video player shall have the ability to verify the authenticity during playback. This authentication shall provide the recorder name, camera name, video time and user information. The authentication shall have the ability to be password protected.

13. Manufacturer: Genetec model Security Center, OnSSI model Ocularis, Exaq model Exaqvision, or approved equal.

E. IP Fixed Interior/Exterior Camera (Base Design)

1. The camera shall be a True Day / Night, and Smart WDR Network IP indoor/outdoor mini-dome white vandal camera with single RJ-45 port for HD quality images, Combining high-sensitivity low-noise CMOS progressive sensor with low-light technology for superior low-light performance Product:

2. The camera shall be equipped with NVT complaint ONVIF Profile S motorized vari-focal P-Iris lens camera powered by PoE IEEE 802.3af/802.3at Type 1 Class 3, 12.95W (priority source) or 24VAC 16.5W.

3. Safety Standards:

   a. UL 60950-1 – Information Technology Equipment

   b. EN 60950-1 – Information Technology Equipment

   c. CSA 22.2 No. 60950 – Information Technology Equipment

   d. IEC 60950-1 – Information Technology EquipmentEmissions Standards:

   e. FCC Part 15 Class A – Commercial or Industrial Use

   f. EN55032 Class A – Information Technology Equipment

   g. AS/NZS CISPR 32 Class A – Information Technology Equipment

   h. ICES-003/NMB-003 Class A – Information Technology Equipment

4. IEEE Standards:

   a. 802.1x Port-based Network Access Control provides authentication mechanism

   b. 802.3: Ethernet standard that specifies physical media and working characteristics of Ethernet.

   c. 802.3af: PoE (Power over Ethernet) standard that provides 12.95 watts (maximum 15.40 watts and 250 mA current) of electrical current over a complaint Ethernet cable (CAT5e or CAT6) as an alternative power source to 24VAC power input for operating the device.

   d. 802.3at: PoE+ (Power over Ethernet Plus) standard that provides 25.50 watts (maximum 30.00 watts and 600 mA current) of electrical current over a complaint Ethernet cable (CAT5e or CAT6) as an alternative power source to 24VAC power input for operating the device.

5. Immunity Standards:

   a. EN55024

   b. EN50130-4

6. The network IP camera shall:

   a. Built-in web server

   b. Support multiple streams, up to 3840x2160 Pixels resolution

   c. Progress scan CMOS imager

   d. Motorized Varifocal P-Iris lens

   e. Onboard SD storage for local recording

   f. IK10 vandal resistant and IP66 / IP67 rating for ingress protection

   g. CE / FCC and UL certification Complies Capable of integration with network recording systems which support iAPI3 or ONVIF Profiles S

   h. Capable of operating as a standalone device on the network

   i. Web Browser access:

      (1) Microsoft Internet Explorer

      (2) Google Chrome

      (3) Mozilla Firefox

      (4) Apple Safari

   j. Streaming methods for audio, video and metadata:

      (1) Unicast

      (2) Multicast

   k. 8MP resolution camera shall support up to 4 streams Enhanced Security :Enhanced Security Feature Provides: One-Click Security Hardening, User Access Log, Validates Complex Credentials, Disables Unused Protocols

   l. Security Key management: Crypto Authentication device for key management and encryption functionality

m. Secure boot, which ensures the camera will not boot if software has tampered with in any way

7. Lens

a. IPS08-D13-OI03

(1) Format: 1/1.8”

(2) Design: Varifocal

(3) Mount: Phi 14mm

(4) Focal Distance: Integrated 3.6 10mm Varifocal Megapixel Lens

(5) Aperture Range: F/1.5 (Wide) ~ F/2.8 (Telephoto)

b. IPS08-D14-OI03

(1) Format: 1/ 2.5”

(2) Design: Varifocal

(3) Mount: Phi 14mm

(4) Focal Distance: Integrated 6-22mm Varifocal Megapixel Lens

(5) Aperture Range: F/1.5 (Wide) ~ F/2.8 (Telephoto)

(6) Focus Type:

(a) One-Touch Motorized Focus

(b) Motorized Varifocal

(c) Lens Calibration

(7) Iris Type: P-Iris

(8) IR Correction: Optical Corrective

(9) Day/Night: True D/N with ICR

(10) View Angles:

c. IPS08-D13-OI03

(1) Horizontal: 95º (Wide) and 49º (Telephoto)

(2) Vertical: 53º (Wide) and 28º (Telephoto)

d. IPS08-D14-OI0

(1) Horizontal: 50º (Wide) and 24.2º (Telephoto)

(2) Vertical: 27.6º (Wide) and 13.7º (Telephoto)

e. Rotations:

(1) Pan Range: 360º

(2) Tilt Range: 90º

(3) Z-Axis Rotation: 356º

f. IR

(1) IR: Adaptive IR

(2) IR Distance: 40m (130 feet)

8. Wide Dynamic Range Methods:

a. SWDR with ICR

b. Digital WDR with ICR

c. Dynamic Range: 110 dB per imager information

9. Electrical Characteristics:

a. Power supply: Dual Power Switch over

b. Input Voltage options:

(1) (PoE) IEEE 802.3af/802.3at Type 1 Class 3, 12.95W

(2) 24VAC (-20% to +30%) Terminal block 2-pin 3.5 mm (47 to 63 Hz)

(3) Current: 0.269A

(4) Wattage: 12.95.W

(5) Surge Protection: Yes

(6) Power Draw 24VAC:

(7) Current: 1.15A

(8) Wattage: 16.5W

(9) Surge Protection: Yes

10. Network Characteristics:

a. Ethernet interface: 10/100/1000 Mbps Ethernet

b. Ethernet port: Single Copper RJ-45

11. Environmental:

a. Cold Start Temperature: -40 C to 60º C (-40º F to 140º F)

b. Operating Temperature: -50º C to 60º C (-58º F to 140º F)

c. Storage Temperature: -40º C to 60º C (-40º F to 140º F)

d. Relative Humidity: 10% to 90% (non-condensing)

12. Manufacturer: Tyco/Illustra.

a. Cameras:

(1) IPS02-D12-OI03 Illustra Pro 2MP MiniDome, motorised P-Iris 2.7-13.5mm, Indoor/Outdoor IP67, IK10, TDN w/IR, TWDR

(2) IPS02-D17-OI03 Illustra Pro 2MP MiniDome, motorised P-Iris 7-22mm, Indoor/Outdoor IP67, IK10, TDN w/IR, TWDR

(3) IPS03-D12-OI03 Illustra Pro 3MP MiniDome, motorised P-Iris 2.7-13.5mm, Indoor/Outdoor IP67, IK10, TDN w/IR, TWDR

(4) IPS03-D17-OI03 Illustra Pro 3MP MiniDome, motorised P-Iris 7-22mm, Indoor/Outdoor IP67, IK10, TDN w/IR, TWDR

(5) IPS05-D12-OI03 Illustra Pro 5MP MiniDome, motorised P-Iris 2.7-13.5mm, Indoor/Outdoor IP67, IK10, TDN w/IR, TWDR

(6) IPS05-D14-OI03 Illustra Pro 5MP MiniDome, motorised P-Iris 6-22mm, Indoor/Outdoor IP67, IK10, TDN w/IR, TWDR

(7) IPS08-D13-OI03 Illustra Pro 8MP MiniDome, motorised P-Iris 3.6-10mm, Indoor/Outdoor IP67, IK10, TDN w/IR, TWDR

(8) IPS08-D14-OI03 Illustra Pro 8MP MiniDome, motorised P-Iris 6-22mm, Indoor/Outdoor IP67, IK10, TDN w/IR, TWDRMounting Adapter Types:

b. Accessories:

(1) Model Number: IPSMDFLUSHOW3

(a) Description: Illustra Pro Series: Recess Mount, Indoor/Outdoor Gen 3

(2) Model Number: IPSMDWALL3

(a) Description: Illustra Pro Series: Wall Mount, Indoor/Outdoor

(3) Model Number: ADCi6DPCAPOW

(a) Description: Illustra 600/610 Dome pendant cap Outdoor, white, ¾" NPT

(4) Model Number: ADLOMARM

(a) Description: Mount, wall arm, no plate

(5) Model Number: ADCDMPOLE

(a) Description: Twin strap clamp pole-mount adaptor for use with ADCDMWALL. White finish.

F. IP Pan/Tilt/Zoom (PTZ) Exterior Camera (Base Design)

1. The specified unit shall carry the following EMC approvals:

a. EN 55032 Class A

b. EN 50121-4

c. EN 55024

d. EN/IEC 61000-6-1

e. EN/IEC 61000-6-2

f. EN 61000-3-2

g. EN 61000-3-3

h. FCC Part 15 - Subpart B Class A

i. VCCI Class A

j. RCM AS/NZS CISPR 32 Class A

k. ICES-003 Class A

l. KCC KN32 Class A

m. KN35

2. The specified unit shall meet the following product safety standards:

a. IEC/EN/UL 60950-22

b. IEC/EN/UL 62368-1

c. IEC/EN 62471 (risk group 2)

d. IS 13252

3. The specified unit shall meet relevant parts of the following video standards:

a. SMPTE 296M (HDTV 720p)

b. SMPTE 274M (HDTV 1080p)

4. The specified unit shall meet the following standards

a. MPEG-4: ISO/IEC 14496-10 Advanced Video Coding (H.264)

b. Networking:

(1) IEEE 802.3at (Power over Ethernet Plus)

(2) IEEE 802.1X (Authentication)

(3) IPv4 (RFC 791)

(4) IPv6 (RFC 2460)

(5) QoS – DiffServ (RFC 2475)

c. Mechanical Environment:

(1) IEC/EN 60529 IP66/68

(2) NEMA 250 Type 4X

(3) NEMA TS-2-2016

(4) IEC/EN 62262 IK10

(5) IEC 60068-2-1

(6) IEC 60068-2-2

(7) IEC 60068-2-6

(8) IEC 60068-2-14

(9) IEC 60068-2-27

(10) MIL-STD 810G

d. Railway environment: EN 50121-4

5. Network: NIST SP500-267

6. The specified product shall meet or exceed the following design specifications:

a. The camera shall operate on an open source and Linux-based platform, and include a built-in web server.

b. The camera shall be equipped with an IR-sensitive progressive scan megapixel sensor.

c. The camera shall provide a removable IR-cut filter, providing day/night functionality.

d. The camera shall be equipped with a zoom lens, providing a horizontal field of view between 58.2 and 2.2 and a vertical field of view between 34.1 and 1.2.

e. The camera shall provide local video storage utilizing a SD/SDHC/SDXC memory card expansion.

f. The camera shall be manufactured with an IP66-, IP68-, IK10- and NEMA 4X-rated aluminum casing.

g. The camera shall be equipped with a built-in wiper in order to remove excess water, rain and snow from the front window.

h. The camera shall be designed to withstand tough weather conditions including wind speed up to 245 km/h (150 mph).

i. The camera shall be designed for mounting facing up or down.

j. The camera shall be equipped with IR illumination, providing a range of up to 400 m (1300 ft).

k. Illumination

(1) Color: 0.07 lux at 30 IRE F1.6

(2) B/W: 0.008 lux at 30 IRE F1.6

(3) Color: 0.1 lux at 50 IRE F1.6

(4) B/W: 0.01 lux at 50 IRE F1.6

(5) 0 lux with IR illumination on

l. Resolution

(1) The camera shall be designed to provide video streams in HDTV 720p (1280x720) at up to 60 frames per second (60Hz mode) or 50 frames per second (50Hz mode) using H.264 or Motion JPEG.

(2) The camera shall be designed to provide video streams in HDTV 1080p (1920x1080) at up to 30 frames per second (60Hz mode) or 25 frames per second (50Hz mode) using H.264 or Motion JPEG.

(3) The camera shall support video resolutions including:

(4) 1920x1080 (HDTV 1080p)

(5) 1280x720 (HDTV 720p)

m. IR Illumination

(1) The camera shall be equipped with built-in IR LEDs, with a range of up to 400 m (1300 ft) with a wavelength of 850 nm.

(2) The camera shall be equipped with built-in IR LEDs with automatic seamless adapting angle of illumination and intensity.

n. PTZ functionality: the camera shall:

(1) Provide more than 255 manually set preset positions.

(2) Provide a preset accuracy of 0.10.

(3) Be equipped with accurate pan and tilt functionality with a range of:

(a) Pan: 360 endless

(b) Tilt -90 to +90

(4) Provide pan and tilt speed in a range of:

(a) Pan: 0.05 - 150/sec

(b) Tilt: 0.05 - 150/sec

(5) Provide optical and digital zoom functionality:

(a) Optical zoom: 30x

(b) Digital zoom: 21x

(6) Provide a guard tour functionality which allows the camera to automatically move between selected presets using an individual speed and viewing time for each preset.

o. Edge storage - the camera shall support continuous and event controlled recording to:

(1) Local memory added to the cameras SD-card slot

(2) Network attached storage, located on the local network

(3) The camera shall incorporate encryption functionality for the SD card.

(4) The camera shall be able to detect and notify edge storage disruptions.

p. Protocol

(1) The camera shall incorporate support for at least IPv4, IPv6 USGv6, ICMPv4/ICMPv6, HTTP, HTTPS, HTTP/2, SSL/TLS, QoS Layer 3 DiffServ, FTP, SFTP, CIFS/SMB, SMTP, mDNS (Bonjour), UPnP® , SNMP v1/v2c/v3 (MIB-II), DNS/DNSv6, DDNS, NTP, RTSP, RTP, SRTP, TCP, UDP, IGMPv1/v2/v3, RTCP, DHCPv4/v6, SOCKS, SSH, LLDP, CDP, MQTT v3.1.1, Syslog, Link-Local address (ZeroConf).

(2) The SMTP implementation shall include support for SMTP authentication.

q. Security

(1) The camera shall support the following:

(a) Secure web browsing

(b) The use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.

(c) Restrict access to the built-in web server by usernames and passwords at three different levels.

r. API support

(1) The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third-party applications.

(2) The camera shall conform to ONVIF profile G as defined by the ONVIF Organization.

(3) The camera shall conform to ONVIF profile S as defined by the ONVIF Organization.

(4) Embedded applications

(a) The camera shall provide a platform allowing the upload of third-party applications into the camera.

s. Enclosure

(1) The camera shall be manufactured with an IP66-, IP68-, IK10- and NEMA 4X-rated aluminum enclosure.

(2) Be fitted with a wiper.

t. Power

(1) The camera shall be connected to a separate midspan and obtain power through a network cable. The midspan shall use 100-240 V AC, max 1.35 A.

(2) Camera consumption:

(a) Max: 71 W

(b) Typical: 25 W

(3) Environmental: camera shall:

(a) Operate in a temperature range of -50 ºC to 55 ºC (-58 ºF to 131 ºF)

(b) Operate in a maximum temperature (intermittent) of 74 ºC (165 ºF)

(c) Start up as low as -40 ºC (-40 ºF).

(d) Operate in a humidity range of 10–100% RH (condensing).

(e) Operate in environment with wind load (sustained) of 68 m/s (150 mph).

7. Manufacturer: Axis Communication. Model Q62145-LE.

G. IP Camera (Optional)

1. The cameras shall include, as a minimum, the following features/functions

a. The cameras shall be a Color Dome Megapixel H.264 Camera and utilize lightfinder technology.

b. The Color Dome Camera and its components shall be thoroughly tested before shipping from the manufacturer's facilities

c. The camera shall carry the following EMC approvals:

(1) EN55022, EN55024

(2) FCC Part 15 - Subpart B

(3) VCCI

(4) C-tick AS/NZS CISPR 22

(5) ICES-003

d. The camera shall meet the following networking standards:

(1) IEEE 802.3af (Power over Ethernet)

(2) IEEE 802.1X (Authentication)

(3) IPv4 (RFC 791)

(4) IPv6 (RFC 2460)

(5) QoS – DiffServ (RFC 2475)

2. The camera shall:

a. Be designed to provide simultaneous Motion JPEG and H.264 (MPEG-4 Part 10/AVC) video, and support resolutions up to 1920 x 1080 pixels.

b. Be designed to provide video at 30 frames per second for all resolutions.

c. Operate on an open source and including a built-in web server.

d. Use a high quality 1/4" progressive scan RGB SMOS sensor.

e. Be fitted with a high quality lens and provide pictures down to 0.3 lux at F1.4.

f. Use a dedicated compression chip, and be equipped with a minimum of 8MB Flash memory and 32MB Random Access Memory (RAM).

g. Provide 9 MB memory for pre & post alarm recordings.

h. Be able to provide a total data throughput of up to 20Mbit/s on the network port.

3. Transmission Speed

a. The camera shall allow the transmission of images at up to 30 frames per second in all resolutions.

4. Image control - The camera shall incorporate Automatic and Manual White Balance and an electronic shutter operating in the range 1/4 and 1/15000 second.

5. Web server

a. The camera shall contain a built-in web server making video and configuration available in a standard browser environment using HTTP, without the need for additional software.

b. When accessed from a browser, the built-in web server shall provide users with online, context-sensitive help.

c. The camera shall not require any additional software to operate, and shall support full functionality when operating in the following environment:

6. Operating Systems:

a. Windows 10

b. Components such as Active X downloaded from the camera shall be signed by an organization providing digital trust services, such as Verisign, Inc.

c. The camera shall support simultaneous viewing by up to 20 clients from the web server.

d. The camera's integral web server shall provide support for defining usernames and passwords, for a minimum of three different types of users.

7. IP addresses

a. The camera shall support both fixed IP addresses and dynamically assigned IP addresses provided by a Dynamic Host Control Protocol (DHCP) server.

b. The camera shall allow for automatic detection of the camera based on UPnP and Bonjour when using a PC with an operating system supporting this feature.

c. The camera shall provide support for both IPv4 and IPv6.

8. Bandwidth management

a. The camera shall

(1) Provide the ability to control network traffic by limiting the maximum bandwidth to a selected value.

(2) Provide the capability to limit the frame rate per viewer to a selected value, as well as the duration of each viewing session.

(3) Support Quality of Service (QoS) to be able to prioritize traffic.

(4) Event functionality

(5) The camera shall be equipped with an integrated event functionality, which can be trigged by:

(a) External input

(b) Video Motion Detection

(c) Audio Detection

(6) Schedule

(a) Response to triggers shall include:

1. Notification, using TCP, SMTP or HTTP

2. Image upload, using FTP, SMTP or HTTP

3. Activating external output

4. Event functions shall be configurable via the web interface.

(7) Protocol support - The camera shall incorporate support for at least IP, HTTP, HTTPS, SSL/TLS, TCP, ICMP, SNMPv1/v2c/v3 (MIB-II), RTSP, RTP, UDP, IGMP, RTCP, SMTP, FTP, DHCP, UPnP, ARP, DNS, DynDNS, SOCKS, NTP and Bonjour.

9. Text overlay. The camera shall:

a. Provide embedded on-screen text in the video, with support for date & time, and a customer-specific text, camera name, of at least 45 ASCII characters.

b. To ensure accuracy, the camera shall accept external time synchronization from an NTP (Network Time Protocol) server. Provide an ability to apply a privacy mask to the image, and shall allow for the overlay of a graphical image, such as a logotype, into the image.

10. Security

a. The camera shall support the use of HTTPS and SSL/TLS, providing the ability to upload signed certificates to encrypt and secure authentication and communication of both administration data and video streams.

b. Authentication shall be possible by using IEEE 802.1x.

c. The camera shall provide support for restricting access to pre-defined IP addresses only, so-called IP address filtering.

d. Access to the built-in web server shall be restricted by usernames and passwords.

11. API support

a. The camera shall be fully supported by an open and published API (Application Programmers Interface), which shall provide necessary information for integration of functionality into third party applications.

12. Network interface

a. The camera shall be equipped with one 100baseTX Fast Ethernet-port, using a standard RJ-45 socket and shall support auto sensing of network speed.

13. The camera enclosure shall include the following:

a. A vandal resistant all metal casing

b. Clear transparent cover

c. The camera enclosure shall provide the ability to adjust the camera modules angle with at least L177\f"Symbol"\s10180° horizontal, ±85° vertical and ±170° rotation while maintaining an image that is not interfered with by the camera housing.

14. Power requirements

a. Power over Ethernet according to IEEE802.3af - Class 1

15. The camera shall:

a. Operate in a temperature range of 0°C to +50°C (32°F to +122°F).

b. Operate in a humidity range of 20–80% RH (non condensing).

16. Manufacturer: Axis. Model M3015 (recessed in ceiling), M3065-V (wall mounted, pendant mounted) or approved equal. Use pendant adapter for pendant mounted camera.

H. Surveillance Keyboard (Joystick and keyboard)

1. The surveillance keyboard shall be an add-on to a video management system (VMS) with the following characteristics:

   a. The surveillance keyboard shall use USB to connect.

   b. The surveillance keyboard shall operate on the following operating system:

      (1) Windows: Windows 10, Windows Server 2016

      (2) Linux: Ubuntu Linux 18.04

      (3) Apple: Mac OSX 10.15

2. The surveillance keyboard shall be part of an integrated system that includes custom firmware to integrate with VMS software.

3. The surveillance keyboard shall have the following components:

   a. Three-axis hall-effect joystick.

   b. 10-button numeric keypad.

   c. 16 user-defined buttons.

   d. Jog/shuttle dial.

      (1) The jog/shuttle dial shall be able to travel 360 degrees.

   e. USB 1.1 interface.

   f. LED-illuminated buttons.

4. The surveillance keyboard shall have the following specifications:

   a. Dimensions: 9 x 11 x 4.36 in (228.35 x 279.40 x 110.74 mm)

   b. Weight: 3 lb. (1.36 kg)

   c. Operating Temperature: -13° F to 185° F (-35° C to 85° C)

   d. Power Consumption: Via USB interface – 5V D, 1A max

   e. Interface: USB, 5-meter cable length maximum

f. Keyboard Housing: High-impact ABS

g. Joystick Performance:

(1) Hall-effect three-axes joystick

(2) X/Y/Z for positioning control

(3) Travel: X/Y axis +/- 18°, Z axis +/- 40°

h. Centering: Single sprint, omni-directional

i. Shaft: Stainless steel

j. Boot: Neoprene

k. Handle: Glass-filled nylon

l. Jog/Shuttle Performance:

(1) Spring-loaded shuttle ruing travel +/- 40°

(2) Smooth-action knob rotates 360°

m. Pushbutton Performance: 27 pushbuttons – 11 fixed and 16 user-programmable

n. Lighting: High-efficiency LED

o. Material: Silicon

5. Manufacturer Axis. Model Number: T8310 or approved equal.

I. Interior IP Camera PoE Extender Unit

1. Provide PoE Extenders for all interior IP video surveillance camera cable runs exceeding 300 feet up to 900 feet.

2. Shall be as manufactured by Veracity Global (Tel. 800-679-1590), Outreach MAX series, model #VOR-ORM, IP camera Power over Ethernet extender, or approved equal.

J. Exterior IP Camera PoE Extender Unit

1. Provide PoE Extenders for all exterior IP video surveillance camera cable runs exceeding 300 feet up to 900 feet.

2. Shall be as manufactured by Veracity Global (Tel. 800-679-1590), Outreach MAX series, model #VOR-ORM-XT, IP camera Power over Ethernet extender, or approved equal.

K. Monitor (not required)

1. The unit shall be a 50" LCD monitor.

2. The monitor shall the following features: VGA and HDMI (3) and full high definition resolution.

3. The monitor shall provide a front panel that allows the user to adjust image quality, brightness, size, position, and geometry for optimal viewing.

4. The monitor shall have improved airflow and thermal reduction allowing for longer component life, ensuring reliability in a 24/7 security installation environment.

5. The monitor shall be constructed of a lightweight aluminum frame composition for desktop or wall-mount installations. Stationary and tilt wall mounts shall be available. The monitors shall provide built-in hand holds in the rear cover for easy installation and handling.

6. The monitor shall be compatible with industry-leading megapixel technology, providing a minimum of 1920 x 1080p native resolution that is used with the latest megapixel video security cameras.

7. The monitor shall meet or exceed the following design and performance specifications.

   a. Electrical

      (1) Input Voltage 100 to 240 VAC, 50/60 Hz

      (2) Power Consumption 122 W

      (3) Video Input Interfaces 2 BNC, looping; 1 S-Video, looping; 1 RGB; 1 DVI-D;

      (4) Audio Input Interfaces 2 audio L/R, RCA jack

      (5) Sync Format NTSC/PAL

   b. Environmental specifications

      (1) Operating Temperature 41° to 104°F

      (2) Operating Humidity 20% to 80%, noncondensing

   c. Physical specifications

      (1) Dimensions (without stand) 3"D x 44.2"L x 25.5"H

      (2) Unit Weight (without stand) 27.7 lb

d. Mechanical specifications

(1) Native Resolution 1920 x 1080p

(2) Panel Aspect Ratio 16:9

(3) Viewing Area 43.3" x 16.6"

(4) Pixel Pitch 0.57 mm

(5) Brightness 300 cd/m2

(6) Contrast Ratio 5000:1

e. Certifications

(1) CE, Class A

(2) FCC, Class A

(3) UL/cUL listed

(4) C-Tick

(5) CCC

f. Warranty 3 year, parts and labor

g. Manufacturer: NEC. Part No. E506 - 50" LCD monitor, WMK3260-L -, tilt wall mount kit, or approved equal.

L. KVM Switch/Rack Monitor

1. The unit shall be single-rail LCD rack console with integrated 8-port KVM switch

2. The unit shall:

a. Take 1U of rack space

b. Be scalable to manage up to 256 systems

c. Include keyed lock to prevent unauthorized access to critical systems

d. Feature wide viewing angle - 115-degree monitor articulation

e. Include premium LCD - High quality TFT-LCD display that provides high resolution support for today's changing requirements

f. Universal mounting - adjustable mounting rails to accommodate most 19" EIA rack/depth configuration

g. Include 2-year warranty

h. Material/Enclosure shall be a heavy-duty steel

i. The weight shall be 33.0 lbs. (15.0kg.)

j. The dimensions shall be 19 x 23.5 x 1.75 inches

k. The unit shall be of Laptop style

l. Keyboard/Mouse Connection shall be PS/2, USB

m. Operating Life of Keys shall be 8 million cycles

n. Mouse Type shall be Touchpad style

o. Display Type shall be 17" LCD active-matrix color

p. Maximum Resolution shall be 1280x1024

q. Power requirements shall be 12V DC

r. Operating Temperature shall be 32° to 104° F (0° to 40° C)

s. Humidity shall be 0-80% RH, non-condensing

3. Manufacturer: Belkin. Model No.F1DC108B-SR or approved equal

M. Surge Protector

1. The unit shall be Power Over Ethernet Power/Video/Data surge protection device.

2. The unit shall be able to protect power, video and date on fixed or PTZ cameras

3. The unit shall include PJ45 connector with external grounding screw.

4. The unit shall be able to maintain Ethrnet data speed without signal degradation.

5. The unit shall comply with IEEE Std. 802.3af and 802.3at for PoE.

6. The protector shall be available as a single device or 12-Port, 2U rack mount.

7. The unit shall meet the following specifications:

a. Connection – RJ-45 In/Out

b. Pinout – all 8 pins shall be protected

c. Data Rate: 100 mbps (100Base-T)

d. Maximum continuous current: 1.5 amp

e. Dissipation: 3000 W/pair

f. Protection mode: Line-Ground (All)

g. Operating temperature: -40ºF - 158ºF (-40ºC - 70ºC)

h. Maximum Humidity: 95% non-condensing

i. Dimensions: 1.7" x 3" 1.2" (43mm x 76mm x 30mm)

j. Housing shall be ABS

k. Warranty: 10 years Limited

8. Manufacturer: Ditek. Model No. DTK-MRJPOE or approved equal.

N. Ethernet and PoE Extender (shall be provided as required)

1. The unit shall be able to extend cable infrastructure to beyond 100 meters.

2. The unit shall be able to forward Power over Ethernet to remote devices.

3. No power cable installation shall be required.

4. The unit shall not have any restrictions to network traffic.

5. The unit shall be able to support all network devices.

6. The unit shall be compatible with IEEE 802.3af PoE standard.

7. Multiple units shall be able to connect multiple chain of up to 100 meters of cables between each unit to total cable length up to 1000 meters depending on power requirements of the connected PoE devices.

8. The unit shall meet or exceed the following specifications:

9. Connector type – RJ45 x 2

10. Rates supported – 100BASE-TX, full duplex

11. Power – 2.2 watts, power in – maximum 12.95; power out – maximum 6.49 Watts

12. The power supply for outsource power shall be available

13. Environmental: -10ºC to 50 ºC

14. Manufacturer: Veracity UK. Part No. VOR-ORM (indoor), VOR-ORM-XT (outdoor) or approved equal.

2.4 ACCESS CONTROL SYSTEM

A. System Software

1. General

a. The system software shall be a true 32-bit application written in C or C++ software language. It shall run under the Windows 10 PRO operating system and be capable of supporting multi-user, preemptive multi-tasking, multi-threaded real-time operations. The system software shall be capable of operating and supporting DOS and Windows applications concurrently without the need to re-boot a computer. Systems utilizing 16-bit application software are not acceptable and will be rejected. Time and attendance control system provided by Owner.

2. Software Features

a. The access control system software shall be a menu-driven, open architecture design that will support the following features:

b. Cardholder Records – unlimited.

c. Card Readers - unlimited.

d. Relay Outputs - unlimited.

e. Client Workstations - unlimited.

f. Operator Passwords – 2,048.

g. Interface with up to unlimited number of Networked Intelligent Controllers

h. Up to 2000 Security Areas (controlled areas).

i. Time Intervals – 8.

j. 255 Time Zones (8 time intervals per time zone).

k. 11 User-Defined Cardholder Fields.

l. Over 70 Data Fields per Cardholder.

m. 512 Action/Instruction Text Messages.

n. Global and Local, hard, soft and timed Anti-Passback/Anti-Tailgate capability.

o. Configurable Alarm-to-Relay Linking, downloaded to Field Controllers for local operation.

p. Configurable automatic Time Zone Controlled commands, downloaded to the Field Controller for automatic local operation.

q. Configurable Automatic, Time Controlled Report Generation and/or Disk Backup commands.

r. Client workstation operations performed utilizing function keys.

s. Visitor logging and badging utility.

t. History/Audit trail.

u. Ability to respond to access requests/alarm conditions before and during download to networked intelligent controllers.

v. Automatic Card Activation and Deactivation

w. Global and Local alarm masking by operator or cardholder

x. Access Activity Analysis by card reader.

y. Host Upload/Download capability to import data from external computer systems.

z. Monitor Point Verification Program supporting the ability to walk test alarmed areas and create reports of the results of the test during on-line operation.

aa. Area Loading/Two-man Control capability.

bb. High Integrity Dial-Up capability to support access control panels and readers at remotely located sites via dial-up communication over public switched telephone network, and to download data base and upload transaction history based on operator commands.

cc. Radio Paging capability to report alphanumerically alarm conditions to designated security personnel through a radio pager interface with the Motorola People Finder Paging System.

dd. Variable Card Formats

ee. Multiple Server Control capability to allow multiple independent ACAM systems to be linked by local or wide area networks or T1 links, to allow sharing of database information and password protected control of each independent system from any server or workstation on any of the systems on the network. Should include capability to route alarm information between systems based on operator command.

ff. Software capability for integrated Video Imaging/Badging System incorporating a complete multi-layer, database keyed badge design facility, bitmap editor, and drawing package. The system must be capable of allowing enrollment facilities at any designated workstation, and displaying photo-images of cardholders at any workstation on an individual system.

gg. Partitioned Database capabilities to provided control and access to specific card records, security areas, alarm points and relay points based on group assignments.

hh. Guard Tour Control and Monitoring of at least 64 guard tours

ii. Local and Global Elevator control functions

jj. Capability to support multiple site and facility codes at Card Readers

kk. Capability to support Temporary Badge issuing and control

ll. Capability to support Biometric Access Control and Verification Readers.

mm. Capability to support Mantrap Control, incorporating weight scale comparison, standard access control card reader and keypad access, and biometric verification.

nn. Capability to support DES encrypted communications between ACAM servers and Networked Intelligent Controllers

oo. Capability to support the requirements of DOD SCIF areas.

pp. Capability to mask and unmask security areas globally from a single card reader/keypad with LCD display prompts.

qq. Capability to support redundant disk drives with automatic switch over in the event of disk failure.

rr. On-Line System Management & Reporting

(1) The system shall maintain, on disk, an Event Transaction Log File, and be capable of Historical Data Reports as well as Cardholder Report Listings in a variety of formats.

(2) System Event Transaction Log File.

(a) The system shall maintain an Event Transaction Log File on hard disk for the recording of all historical event log data.

(b) The historical data file shall maintain the most recent 1 million event transactions without having to resort to archived media.

(c) The system shall warn the user of the need to archive historical data before data is over-written.

(d) The system shall provide the utilities by which the historical event log file may be backed up to a removable disk cartridge of not less than 1-GB capacity, which may be accessed on-line, without the need to copy the archived data back to hard disk. The system must be capable of recalling historical events directly from the back up magnetic media without the need to interrupt normal on-line activity of the ACAM system.

(3) System Historical Reports.

(a) The system shall be capable of producing the following reports, based on logged historical events over a specified date and time period, both individually and in any combination.

(b) Report of valid accesses for a selected cardholder, group of cardholders, selected card reader, group of card readers and selected areas.

(c) Report of rejected access attempts for a selected cardholder, group of cardholders, selected card reader, group of card readers and selected alarm activation's for a selected alarm point, group of alarm points, selected category or type of alarms, and by selected areas or group of areas.

(d) Report of alarm acknowledgments for a selected alarm or group of alarms.

(e) Report of operator entered comments in conjunction with alarm acknowledgments.

(f) Report of manual operator override commands such as performed alarm point masking/unmasking, manual card reader door locking and unlocking, and manual auxiliary relay activate/deactivate.

(g) Report of automatic time controlled system commands such as automatic masking/unmasking, and automatic door lock/unlocks.

(h) Report of visitor card valid access and rejected access attempts.

(i) Report of access statistics including the number of valid accesses, rejected access attempts, and card read errors, reported by selected card readers, or group of card readers, or by selected areas, over a selected date and time period.

(j) In addition, the system shall offer the user the option of directing the historical reports to a client workstation color monitor for display or to the report printer.

(4) Cardholder Reports.

(a) The system shall be capable of producing lists of selected cardholder data records on a client workstation color monitor and/or a report printer. The system shall allow the user to select sorting by card number, cardholder name or other fields.

(b) Standard Cardholder Record Reports may be requested by an operator, with the data records sorted numerically by encoded card number, alphabetically by cardholder name, numerically by cardholder ID number, and numerically by the embossed card serial number. Such listings may also be requested to include only those cardholders who are authorized access to a specified area.

(c) Special Ad Hoc reports may be created by the operator to provide cardholder record listings that include only operator specified data fields. Each report may include conditional testing on up to sixteen (16) data fields in order to include data for only those cardholders that comply to those conditions specified. Each report shall be capable of being sorted in alphabetical or numeric order.

(d) Cardholder Report Formats: The system shall allow the user to create and design the Ad Hoc reports with report Format Names. The system shall save and store these named formats on the system hard disk for later use and recall by format name.

(e) Custom Reporting Facilities

(f) The system must be provided with an ODBC Compatible database with full SQL facilities, which will allow the interfacing of industry standard report generating facilities such as Crystal Reports, Oracle, or Informix.

B. Card Access Control Operational Objectives

1. Controlled entry, via access card readers, of only authorized personnel to secured areas based on cardholder information entered and stored in the system database.

2. The access request response time from card presentation, data base verification, to electric lock unlock shall be no more than one second in normal operating mode on a fully loaded system.

3. All access requests, both authorized and denied, shall be sent to the host for storage and annunciation, as required, with the cardholder number, name, and access point/area where access was attempted or gained.

4. The software package shall provide for Global and Local Anti-Passback, and also provide a facility for "soft" Anti-Passback (i.e. allowing entry following an Anti-Passback violation but still report and log the violation.) The system shall also be capable of providing timed Anti-Passback at individual readers, and the time shall be capable of being selected by the operator.

5. The system shall provide for automatic lock/unlock of access controlled doors on a scheduled basis using time zones.

6. Each card and cardholder shall be entered into the database prior to their use. Each card can be manually disabled at any time without the requirement to delete the card. Each card can then be subsequently re-enabled at a later time.

7. Card records shall include the entry of activation and deactivation dates to provide for the automatic enabling and expiring of the card record.

8. The system shall provide the capability of setting a parameter of a number of days whereby cards will be automatically disabled if they are not used at all for access for that preset number of days (i.e. 30 days, 60 days, etc.). Any card can be subsequently re-enabled at any time.

9. The operating mode of access controlled doors shall be indicated as locked, unlocked, or controlled. The door status shall be indicated as open or closed.

10. The system shall provide for the monitoring of the reader controlled door position in order to detect and report Door Forced Open and Door Held Open alarm conditions. Door Held Open condition shall be based on a user-adjustable time period. The act of opening the door shall initiate the door timer, and also cause the immediate reset of the door lock.

11. Each cardholder shall be specified with access authority to a combination of up to 64 Security Areas and 64 groups of Security Areas, each security area comprised of one or more card reader controlled door. Up to 255 Security Areas may be defined. Each individual security area or group of Security Areas designated as authorized to an individual cardholder shall include a time zone assignment for that specific area. Each cardholder may be specified as authorized access to any, or all, or any combination of the 256 Security Areas.

12. The system shall provide for the designation of certain calendar days to be holidays, with special access privileges and system activity to be specified for those days.

13. The system shall provide the capability to unlock the door and/or mask (shunt) the door alarm, as user-configured, via a request-to-exit door motion sensor device or exit push-button. The capability shall be software programmable to allow selectable exit reporting.

14. All system controlled electric locks shall be capable of being unlocked via a client workstation color monitor/keyboard and request-to-exit devices.

15. The system shall provide for a completely downloaded and distributed database such that access control decision are made locally at the access controller. In the event of the failure of the host computer or loss of communications to the host computer, the access control system shall continue to operate using full data base information for all cardholders including security areas authorizations, time zones, expiration dates of cards, holidays, etc. At no time after a card has been entered into the database of the file server and validated, shall the system fail to respond to an access request by a valid cardholder. (Restricted subsets of access control privileges and time zone facilities in the distributed database will not be accepted).

16. The system shall be capable of utilizing a partitioned database to restrict a user from viewing, adding and editing card records and security areas, as well as accessing and controlling alarm points and relay points. The system shall utilize a group ID assignment to restrict each user from the partitioned database.

C. Relay Output Control and operational functions:

1. Each security system output point (door lock, gate controller and other associated relay outputs) shall have a user-specified 16 character, minimum, test identifier. Each point shall be software programmable for activation and deactivation, and shall be capable of reporting short circuit trouble, open circuit trouble, ground fault trouble and circuit fault trouble.

2. The system shall allow activation and deactivation of output points manually by the operator, automatically by time zone, automatically by the activation of an alarm point, or, where required, by a card reader.

D. Data Management Capabilities:

1. The software shall be capable of providing for the recall of system historical transactions with a minimum of 1,000,000 transactions recallable by operator command from the main event transaction file on the file server hard disk. Additional events may be recalled directly from an archived history log file on a removable hard disk cartridge.

2. Data searching parameters shall be provided as a menu driven feature of the ACAM system software. The search capability shall include, but is not limited to the following:

a. Card Activity.

b. Cardholder, by Card Number or Name.

c. Card readers.

d. Security Areas

e. Alarm Points

f. Alarm Categories

3. The software shall provide report creation capabilities which offer search, organize and sorting according to the operator instructions, and have the ability to print, spool, or display a full report at a printer or client workstation.

4. All operator commands and data base entry functions shall be completely menu driven with plain English text and prompts, and the system shall provide on-screen `Help' information.

5. All access to the operator system functions shall require the entry of a valid password. A password must be used by the operator, manager, or administrator to access the system, with each password access authority being completely user-selectable by individual menu selection.

E. Graphical User Interface

1. Graphical User Interface shall be provided for true real time integration of the diverse security systems: Alarm Monitoring, CCTV, Intercom and other systems. The system shall be able to control all systems from single GUI.

2. GUI shall be capable of on-screen control of doors, alarms, cameras, etc. via icons. Device control (such as camera pan/tilt control) can be displayed as desired.

3. The control buttons shall be seen only when the icon/device to which they apply is activated.

4. GUI shall support real time status display. Status of each device shall be shown by icon color and text display. Complete system status shall be shown in the status control list.

5. GUI shall support event-driven micros to allow global linking between various systems to automate alarm response and control. Alarm events should be able to call up cameras, turn on lights, start recorders, etc.

6. GUI shall support user portioning. Control, alarm acknowledgment and alarm bypass privileges shall be assigned to user groups.

7. GUI shall support comprehensive logging and advance log reporting. If the video is saved for logged events, the video files shall be accessible through log report generator (click the video icon next to the event and video is played).

8. GUI shall be operable on LAN/Wan networks. All data transmission shall be encrypted for security.

F. Video Imaging System

1. Capture/Workstation Platform

a. Workstation platform: (Client) workstation shall be 10th Generation Intel Core i7-10700T (8-Core, 16 MB Cashe, 2.0 GHz to 4.5 GHz, 35W) running the Microsoft Windows 10 PRO operating system.

2. The PC shall have the following minimum configuration:

a. 16 GB RAM

b. M.2 256 GB PCIe NVMe Class 40 Solid State Drive

c. 19" monitor

d. Windows 10 PRO operating system

e. Graphic Card: NVIDIA® GTX 745

f. Ports and Slots:

(1) Power Button

(2) Universal Audio Jack

(3) Line Out

(4) USB 3.2 Gen2 Type-C Port

(5) USB 3.2 Gen 2 Type-A Port (with PowerShare)

(6) Wireless Antenna Slots

(7) Optional: Serial RS232/PS/2 Ports/DP1.4/HDMI 2.0b/VGA/USB 3.2 Gen 2 Type C with DP Alt Mode

(8) RJ-45

(9) 2 USB 3.2 Gen 1 Type-A Ports (1 with Smart Power on)

(10) 2 USB 3.2 Gen 2 Type-A Ports

(11) Cable Clip

(12) Thumbscrew

(13) Kensington lock slot

(14) 2 DisplayPort 1.4

(15) Power Connection (DC-in)

3. Capture Station

   a. The capture station electronically text data and portraits for each badge holder. Using the electronically stored data the system shall send this information to the color I.D printer.

   b. The capture station shall consist of a computer, color monitor, keyboard, mouse and RGB color camera, lens and power supply.

   c. Manufacturer: Logitech. Model C920 or approved equal

4. Software

   a. Security

      (1) The System log in shall require a valid password. The system shall have multiple user access levels including but not limited to the following levels:

         (a) Level 1 - All system functions (no restrictions.)

            1. Create a badge

            2. Edit data

            3. Edit security database

            4. Badge design

            5. System backup

            6. Data and image export

            7. System setup

         (b) Level 2 - Operator functions

            1. Create a badge

            2. Edit data

         (c) Level 3 - View and read only.

   b. The system shall automatically create an audit trail that will allow the system administrator to display and print a report of the system history.

   c. The system shall have the capability to work in the off-line mode.

d. A minimum of (5) different back grounds and logos. Complete control and flexibility of card layout, colors, type font and graphics.

e. On screen card design, "WYSIWYG".

f. Card format must include logo and background.

g. Microsoft Windows 10 PRO operating environment.

h. Open system architecture.

(1) The system shall be fully compatible with the access control system.

(2) Cardholder data shall be automatically transferred from the video identification system to the access control system ensuring that data entry is only performed once.

i. Database

(1) All limits on fields shall be data base dependent.

(2) The system shall have a minimum of forty (40) user defined database fields.

(3) The system shall have the ability to run custom user created reports of any combination of database fields. The system shall allow the user to run reports in ascending or descending order.

5. Color I.D. Printer

a. The color I. D. printer shall be PC driven and connected to the network server. This device shall process and card entry I.D. badges.

b. The printer shall be capable of dual side printing full color photos, bar codes, alphanumeric text, graphics and background patterns.

c. The printer resolution shall be a minimum of 300dpi.

d. The printer shall be capable of printing on a PVC type card.

e. Processing speed shall be less then (2) minutes.

f. Overlay capabilities

g. Security and protective overlay application.

h. Protective, full card or partial card and clear and custom holographic overlays.

i. Automatic card feed

j. Manufacturer: Fargo DTC 4500 – or approved equal. The system shall include: single side printer, dual sided printing module for barcode encoding, Fargo DTC525 YMCKO ribbon full color and a clear overlay panel with 500 image capacity, digital high resolution web camera.

k. Identification Badges

(1) Dimensions

(a) ANSI/ISO 7810-1985 Compliant (85.6mm x 54.0cm)

(b) Thickness (0.8mm).

(c) Material (PVC)

G. Visitor Management System (VMS)

1. Overview

a. The system shall support integration to the LobbyWorks™ Visitor Management System to allow the user to track visitors, employees, assets and deliveries as they enter and exit the facilities. The system shall reduce visitor queues by automatically processing multiple visitors simultaneously at one station. The system shall support printing of custom-designed visitor passes with expiration date; visit area, host being visited, and visit purpose.

b. In addition, LobbyWorks shall allow the user to keep track of contractors and consultant time sheets, track which employees have regular personal visitors, secure visitor log. Clearly identify visitors by category to restrict access to vulnerable goods and information. Designate special areas for visitors with custom badges. Process most visitors in 20 seconds or less. Label information packets with personalized customer information. Track and print temporary parking passes. Print vehicle window stickers. Use TEMP badge self-expiring badges to tighten security. Generate end-of-day reports to ensure regulatory compliance.

2. Visitor Pre-Registration

a. The system shall support visitor pre-registration to include security level and access areas, length of stay, and maximum entries. Pre-registration shall be accomplished from Microsoft Outlook® or Lotus Notes® Calendar or through Web-based pre-registration.

b. The system shall support group/event pre-registration, pre-loading of visitor picture, badge pre-printing, and arrival instructions/greeting. The system shall provide visitor registration within 10-15 seconds per visitor.

3. Visitor Information Capture

    a. The system shall support quick and complete capture of visitor information as an essential component for proper record keeping and security checks.

    b. The system shall support various hardware devices in order to capture visitor information, including but not limited to scanning business cards, scanning driver licenses, capturing visitor photo, capturing visitor signature, and 2-D barcode scanning of driver licenses. The system shall support quick processing of large groups of visitors through queuing of captured data.

4. Visitor Authentication

    a. The system shall be capable of authenticating a person as having proper identification and determining that he or she is who they claim to be. The system shall support the recall of returning visitor information, including pictures. The system shall detect each attempted visit and deter potential security breaches before they impact the user facilities.

    b. The names of unwanted guests, ranging from disgruntled ex-employees to known felons, shall be capable of being imported into the Watch List, including cross-matching for alias names, to alert personnel of a potential threat to the organization. The system shall provide challenge questions for pre-authorized visitors and authenticate driver license.

5. Visitor Authorization

    a. The System shall enforce visitor authorization prior to printing a badge and entering the premises. The system shall authorize visits at reception, security lobby, or remotely by the host employee.

    b. The system shall support delegation of authorization responsibility to specific individuals. The system shall also provide host-specific pre-authorize and deny list.

6. Visitor Badges Generation

    a. The system shall provide quick, cost-effective and individualized badging as an essential component of proper visitor identification. The system shall allow for printing of individualized visitor badges containing: name, picture, expiration date, and valid access areas. The system shall support customize badge templates for visitors, VIPs, contractors and any other types of visitors. The system shall support printing of badges on:

        (1) Thermal label printers: Dymo 330 and 330 Turbo – thermal paper labels

        (2) Dye Sublimation – PVC cards

        (3) Ink/Laser printer – Regular card stock

7. Host Notification

   a. The system shall notify host of a visitor's arrival by e-mail, office phone, mobile phone, or real-time network messaging.

   b. Delegated notification and customizable announcement shall also be provided. The system shall notify host when a visitor does not sign out.

   c. Visitor Tracking

      (1) The system shall keep an accurate log by automatically tracking events as they relate to the visitor's activities on site. The system shall track visitor sign in and sign out times. The system shall also support quick sign in and out using a barcode scanner.

      (2) The system shall provide proactive checking for expired visits and network notification to hosts and visitors of expired visits. The system shall provide Web access to the visitor manifest including emergency roll-call procedure support through eManifest. Web-based checkpoint stations shall be supported to check the validity of badges and quickly sign them in and out through eCheckpoint.

8. Security Policies

   a. The system shall allow for accurate and consistent application of security policies. The system shall check each visitor against the host employee's personal pre-authorized and denied visitors list, including a watchlist of barred visitors.

   b. The watchlist shall provide viewing of picture and person's attributes, reason for being on the watchlist, and action to perform upon arrival. The system shall check each visitor against his/her previous visit information. The system shall ensure that visitors sign out by tracking expired visits and informing their hosts. A host shall be allowed to extend a visit or assign host responsibilities to another employee.

9. Host Management

   a. The system administrator shall have full controls over what capabilities are available to which employees.

   b. The system administrator shall be allowed to differentiate permanent and temporary employees, control which employees can have visitors, limit the number of daily and concurrent visitors per host, pre-authorized visitor list and personal denied visitor list.

10. Traffic Reporting

a. Visitor traffic reports shall be available to plan resource allocation and measure productivity and facility utilization.

b. The system shall generate:

(1) Traffic reports – per station, per building, per company, per employee, and per department

(2) Detailed visit reports

(3) Time and attendance reports for contractors and other visitors

(4) Reports on demand or schedule reports for regular generation and email delivery

11. Assets and Deliveries

a. The system shall track assets and deliveries as they enter and leave premises. The system shall have the capability to generate asset and delivery tags and to scan assets and deliveries in and out with a barcode scanner.

b. The system shall provide e-mail notification of delivery recipient and for unreturned assets.

12. Security Audit Compliance

a. The system shall provide the necessary tools to perform security and compliance audits including:

(1) Secure database

(2) Audit log

(3) Tamper proof visitor records

(4) Audit reports

(5) Backup and restore capabilities

13. Installation - The system shall provide a simple installation process, including wizard-based installation, attended and unattended installation support, and batch import of employee data.

14. Flexibility

a. The system shall be designed to meet the needs of large and small companies in many industries. The system shall support configuration as a standalone or networked solution, single or multi-tenant facility, or single or multiple facility company. The system shall support tailored badge templates, notification rules, and security policies for each visitor category.

b. The system shall provide customization of what data is being tracked for each visitor category and customized report templates. The system shall support synchronization with online employee list through automated file import, active directory, or MAPI address book. The system shall support configurable user interface including, but not limited to data views, actions, field names /types/default values, custom categories, visit types, required or read-only fields.

15. Extensibility - The system shall provide the necessary tools to easily integrate with other security and enterprise solutions. These tools shall include, but not be limited to, programmable Web interface for integration with Web-based conference solutions and open API to integrate with other enterprise systems.

16. Advanced Features

a. The system shall support the following advanced features:

(1) System Login - The system shall support two modes of login

(2) The system shall support explicit user ID and password. The system shall store all passwords in an encrypted format.

(3) The system shall support integrated single sign on.

b. Multiple Language Support

(1) Users shall have the capability to access the system utilizing different languages on the same installation.

(2) The self-registration kiosk shall also allow visitors to choose their preferred language.

(3) Commercial Scalable Database

(4) The system shall utilize a commercial scalable database including Microsoft MSDE or Microsoft SQL Server.

(5) Full SQL Server licenses shall not be required for database storage of 100,000 visit records or less.

c. Traffic Control - The system shall provide the capability to limit the number of simultaneous visitors per host, as well as the maximum number of visitors per host, per day.

d. ID Authentication - The system shall support a comparison of driver license printed data against the data in the 2-D barcode or magnetic stripe to ensure that the ID is authentic

e. Temporary Host - The system shall provide the capability to enroll temporary employees with automatic inactivation after a predetermined period of time. This shall allow, for example, contractors to act as hosts for other visitors while working on site for a certain period of time.

17. The CPU hardware and Visitor Management System license will be provided by Owner.

18. Provide the following hardware:

a. Visitor badge printer – Dymo LabelWriter 450 or approved equal

b. Business card/Driver license scanner – ScanShell 800NR or approved equal

c. Capture camera – Logitech C920

H. Manufacturer: Software House model C-CURE 9000, or approved equal.

I. System Hardware

1. Access Control/Alarm Monitoring Workstation

a. CPU – Intel Core i7 (2600)

b. RAM – minimum of 16 GB

c. Network – Gigabit Ethernet connection

d. Graphic Adapter – PCI, AGP, PCI-Express, minimum 1280 x 1024, 16 bit color

e. Quad output Graphic Accelerator (ATI FirePro 2450 or equivalent)

f. Hard Disk Type – 1000 GB E-IDI, PATA, SATA, SCSI, SAS (7200 RPM or faster)

g. Hard Disk space – RAID 1 minimum 50 GB free.

h. Operating System – Microsoft Windows 10 .

i. Power – 120 VAC, 650 watt.

j. Manufacturer: Dell OptiPlex 7080 (Micro for VMS) or approved equal.

2. Access Control/Alarm Monitoring Server

a. Quad Core Intel® Xeon® 5500 series

b. 4MB Cache

c. Operating System Microsoft Windows Server® 2019

d. Memory up to 128 GB

e. PCI Riser with 2 PCIe Slots

f. Chassis Configuration Rack Chassis w/Sliding Rapid/Versa Rails and Cable Management Arm, Universal

g. Power Supply 750 Watt

h. Hard Drive Configuration Integrated SAS/SATA RAID 1, PERC 6/i Integrated/SAS6/iR

i. Backplane 2x2 Backplane for 3.5-inch Hard Drives

j. Primary Controller SAS 6/iR Integrated Controller

k. Primary Hard Drive 73GB 15K RPM Serial-Attach SCSI 3Gbps 3.5-in HotPlug Hard Drive

l. 2nd Hard Drive 73GB 15K RPM Serial-Attach SCSI 3Gbps 3.5-in HotPlug Hard Drive

m. Internal Storage 8TB up to 24 TB

n. Network Adapter Dual Embedded Broadcom® NetXtreme II 5708 Gigabit Ethernet NIC

o. Optional Feature Upgrades for Integrated NIC Ports LOM NICs are TOE Ready

p. CD/DVD Drive 24X IDE CD-RW/DVD ROM Drive

q. Mouse, keyboard and monitor (for initial setup)

r. Manufacturer: Dell Computers. Model: Poweredge R540 or approved equal.

3. Hot Redundant System Operation shall support:

a. Complete and true Hot Redundant System operation that shall operate with two (2) fully redundant ACAM File Servers with a high speed parallel communications link between the two systems.

b. When operating in redundant system mode, one file server shall be operating as the Primary, while the other operates as the Secondary. The Hot Redundant System shall update the Primary and Secondary file servers on any system and/or database changes such that if the Primary file server should fail for any reason, the Secondary file server will automatically assume complete control of all system functions.

c. The Hot Redundant System file servers shall be monitored by a microprocessor controlled Dual System Controller which shall monitor and identify any system failure and automatically switch control to the Primary/Secondary file server as well as switching all field devices to the Primary/Secondary file server.

d. Upon any detected failure of the Primary file server, the system shall perform a complete switchover to the Secondary file server in 20 seconds or less, with no data loss.

4. Intelligent System Controller

a. The controller shall be manufactured in accordance with ISO 14001 and be compliant with 2011/65/EU (RoHS), 2012/19/EU (WEEE) and 1907/2006 (REACH) EU regulations/directives.

b. The controller shall meet product standards as defined in UL 2043

c. The controller shall meet product safety standards as defined in UL 294

d. The controller shall meet product safety standards as defined in UL 294B (Standard for Power over Ethernet (PoE) in Access Control Systems and Equipment)

e. The controller shall meet ONVIF Profile C Version 1.0 or higher as defined by the ONVIF organization.

f. The controller shall carry the following EMC approvals:

(1) EN55022 Class B

(2) EN55024

(3) FCC Part 15 - Subpart B Class B

(4) VCCI Class B

(5) C-tick AS/NZS CISPR22 Class B

(6) ICES-003 Class B

g. The controller shall meet the following standards:

(1) IEEE 802.3af/802.3at (Power over Ethernet)

(2) IEEE 802.1X (Authentication)

(3) IPv4 (RFC 791)

(4) QoS – DiffServ (RFC 2475)

h. Mechanics & environmental

i. The controller shall be manufactured with a metal body, UL94 plastic casing and be fitted with tamper switchers and concealed cable entries.

j. The controller shall operate in a temperature range of 0°C to +50°C (+32°F to +122°F).

k. The controller shall operate in a humidity range of 20-80% RH (non-condensing).

l. Readers

(1) The controller shall support at least two connected readers and support both Wiegand and RS485 (OSDP) interfaces.

(2) The controller shall provide at least two dedicated control outputs.

(3) The controller shall provide two blocks of 4 ports, configurable as in- or outputs, which can be used for beep, LED-functionality or other auxiliary functions.

m. Doors

(1) The controller shall support at least one door equipped with dual readers for entry and exit, or two doors when not using exit readers.

n. Auxiliary

(1) The controller shall be equipped with two ports, configurable as either input or output.

o. Connectors

(1) The controller shall through color-coded removable terminal blocks provide at least:

(a) For door control

(b) Four door monitor/REX inputs, supporting +40 V DC

(c) Two high power 12 V DC outputs for door control

(d) For the readers

(e) Two RS-485 serial port for reader including reader LED control

(f) RS-485 serial port for reader including reader LED control

(g) Four input ports, supporting 40 VDC, configurable to respond to normally open (NO) or normally closed (NC) dry contacts.

(h) Two input ports, supporting 40 VDC, configurable to respond to normally open (NO) or normally closed (NC) dry contacts

(i) Auxiliary Inputs/Outputs

1. One output port providing 3 VDC, max 100mA, for auxiliary items

2. Two ports which can be configured as digital (alarm) inputs or digital outputs, support 40 VDC, which when used as inputs shall support to respond to normally open (NO or normally closed (NC) dry contacts for auxiliary devices.

p. Power

(1) Connectivity for power, 10-30 VDC.
(a) Network:

1. The controller shall be equipped with a RJ45 10BASE-T/100BASE-TX PoE Ethernet port.

2. The controller shall through color-coded removable terminal blocks provide connectivity for power, 10-30 V DC.

(b) The controller shall be equipped with a RJ45 10BASE-T/100BASE-TX PoE Ethernet port.

q. Functionality

(1) The controller shall support up to 15.000 defined cardholders, holding individual clearance codes.

(2) The controller shall support the following access control functions:

(a) Card only

(b) PIN only

(c) Card + PIN

(d) The controller shall provide correct response within no more than 500mS of presenting a card or PIN-code to the reader.

(e) The controller shall support individually adjustable shunt times for each door.

(3) Event functionality

(a) The controller shall be equipped with an integrated event functionality, which can be trigged by:

1. External input
2. Cover removal
3. Removal from wall
4. Network loss
5. Invalid credentials
6. Schedule
7. Door open too long
8. Door forced open
9. Remote trig by HTTP-request
10. Changes in the units configuration

(4) The controllers' response to a trigged event shall include:

(a) Notification, using TCP, SMTP or HTTP

(b) Activating external output

(c) The controller shall hold a history of the last 30.000 events.

(d) The controller shall be able to respond to triggers from other controllers on the same network, and also be able to generate response in other controllers as result of a trigged event.

(5) Other functionality

(a) The controller shall support time schedules to be defined, only limited in number by the controllers total memory usage.

(b) The controller shall support a cluster of up to 33 controllers located on the same network and provide full functionality without the requirement for a defined master controller.

(c) The controller shall support the creation of holidays/exception-days in the calendar.

(6) Network functionality

(a) The controller shall support both static IP addresses and addresses from a DHCP-server.

(b) The controller shall incorporate support for UPnP and Bonjour.

(c) To secure access to the unit as well as provided content, the unit shall support HTTPS, SSL/TLS and IEEE802.1X authentication and communication between controllers and application shall be done using at least 256-bit AES encryption.

(d) The controller shall support IP address filtering and include at least three different levels of password security.

(e) The controller shall support time synchronization via NTP server.

(7) The controller shall support input voltage in the range of 10 - 30 V DC, max 26 W.

(8) The controller shall be able to provide power to connected devices with:

(9) 12 V DC max 500mA for accessories and relays

(10) 12 V DC max 500mA for door look

(11) 12 V DC max 300mA for readers

(12) The controller shall, when connected to DC-power, be able to provide 14W to connected devices.

r. Maintenance & service

(1) The controller shall provide a log file, containing information about all users connecting to the unit since last restart. The file shall include information about connecting IP address and the time of connecting.

(2) The controller shall be monitored by a Watchdog functionality, which shall automatically re-initiate processes or restart the unit if a malfunction is detected.

(3) All customer-specific settings, including card holder and event log, shall be stored in a non-volatile memory and shall not be lost during power cuts or soft reset.

(4) Through its web interface and API provide current status of all inputs and outputs, and also provide ability to force-control outputs for test purpose.

(5) API & applications

(a) The unit shall contain a built-in web server making configurations and event history available to authorized users in a standard browser environment using HTTP.

(b) The controller shall be fully supported by open and published API (Application Programmers Interface) providing necessary information for integration of functionality into third party applications.

(c) The controller shall conform to ONVIF Profile C Version 1.0 or higher as defined by the ONVIF organization and be upgradable at any time.

s. Manufacturer: Software House model iSTAR, Ultra or approved equal. Enclose the modules to Safety Power enclosures. Use Safety Power FPO series power supplies for electrified door hardware and for access control modules.

5. Card reader

a. The multi-technology contactless smart card reader shall be optimally designed for use in access control applications by providing:

(1) Customized security protection through support of the device-independent Secure Identity Object™ (SIO) portable credential methodology to provide enhanced security and performance features.

(2) Unique read selection that enables reading of the Secure Identity Object™ (SIO), standard iCLASS, 125 kHz proximity, or multiple technologies at the same time.

(3) Participates in an advanced, bounded and trust-based security system utilizing the Trusted Identity PlatformTM (TIP) architecture.

(4) A migration platform to upgrade from the most popular 125 kHz proximity technologies to SIO on iCLASS Seos smart cards and Mobile IDs by reading both 125 kHz proximity technology and 13.56 MHz contactless smart card technology / NFC and 2.4GHz Bluetooth Smart technology.

(5) Guaranteed compatibility to read all HID data formats and ensuring card-to-reader interoperability in multi-location installations and multi-card and reader populations when used with Genuine HID products.

(6) Backwards compatibility with legacy 13.56 MHz contactless smart card and 125 kHz proximity access control formats (E.g. 26-bit, 32-bit, 35-bit, 37-bit, 56-bit, and HID Corporate 1000 formats). Compatibility across the product line shall be assured without the need of special programming.

(7) Global, off-the-shelf availability.

(8) Enables secure access with a mobile device by leveraging standard communication technologies that work with both iOS® and Android™ operating systems. Including validation of support with a minimum 15 different mobile device models.

(9) Enhances the transactional experience by opening doors with a tap or "Twist and Go" gesture, merging security with convenience. Including ability to configure the read range and interaction mode via Android mobile device app.

(10) Simultaneously support of BLE Mobile Devices, NFC Mobile Devices and 13.56MHz and 125kHz contactless credentials. Supporting new Mobile IDs and existing card populations for seamless migration to a more secure standard.

(11) Reader can be purchased as "mobile-ready" to be installed in preparation for moving to mobile at a later time. Once user decides to move to mobile it can be configured via configuration card for the users specific requirements.

(12) No special system modifications are required to read mobile credentials. Existing Wiegand readers can easily be replaced and work with existing access control panel hardware.

b. The multi-technology contactless smart card reader shall provide enhanced security technology and features.

c. The multi-technology contactless smart card reader shall be Secure Identity Object™ (SIO) enabled. The multi-technology contactless smart card reader platform shall support the standards-based, device-independent Security Identity Object™ (SIO) portable credential that binds the credential to the physical media to ensure data authenticity and privacy. The SIO shall be able to reside on any number of identity devices, including Mobile ID, iCLASS Seos, iCLASS SR, MIFARE Classic, and MIFARE DESFire EV1 credentials.

d. The multi-technology contactless smart card reader shall be a certified end-point (TIP Node) within a Trusted Identity Platform™ (TIP) infrastructure. TIP shall provide a scalable, on-demand, secure identity delivery system that validates, registers and provides lifecycle management support for certified trusted end-point multi-technology contactless smart card readers.

e. The multi-technology contactless smart card reader shall increase security by narrowing the possibility of unwanted configuration changes and denials of service. The multi-technology contactless smart card reader shall utilize TIP-enabled secure configuration of multi-technology contactless smart card readers with counters and uniquely diversified configuration cards.

f. The multi-technology contactless smart card reader shall utilize Secure Element Technology™ to protect keys and cryptographic functions to the international standard Evaluation Assurance Level (EAL) 5+.

g. The multi-technology contactless smart card reader shall be configurable to utilize Velocity Checking to provide breach resistance against electronic attacks that invoke multiple improper authentication attempts.

h. The multi-technology contactless smart card reader shall be configurable to provide multiple hierarchical degrees of key compatibility for accessing the smart card access control data. Compatibility shall be provided for the following key structure options:

(1) Compatibility with the standard SIO and iCLASS access control application data model to ensure convenient off the shelf compatibility with Mobile IDs, iCLASS Seos, iCLASS SR, and iCLASS credentials.

(2) Compatibility with higher security SE Elite credential programming that uniquely assigns a reader and credential keyset that provides site-specific security.

i. The multi-technology contactless smart card reader shall have a unique electronic serial number.

j. The multi-technology contactless smart card reader reads Mobile IDs powered by the Seos standard based software application or applet technology. Seos technology is independent of communication medium (ex. 13.56Mhz ISO14443A or 2.4HGz BLE allowing for a unified security platform across credentials using BLE, NFC and contactless smart card credentials.

k. The multi-technology contactless smart card reader shall provide enhanced usability features.

(1) The multi-technology contactless smart card reader shall simplify troubleshooting through Anti-passback Notification that the card has already been processed and it must be removed from reader field temporarily prior to processing again.

(2) The multi-technology contactless smart card reader shall provide enhanced user feedback options through the use of clear and bright tri-colored LEDs configurable to support any three color combinations (RGB - Red, Green, and Blue).

(3) The multi-technology contactless smart card reader shall enable ease of installation through identical wiring methods as legacy 13.56 and 125 kHz proximity readers.

(4) The multi-technology contactless smart card reader shall enable backwards compatibility with legacy 13.56 MHz and 125 kHz proximity access control formats (E.g. 26-bit, 32-bit, 35-bit, 37-bit, 56-bit, and HID Corporate 1000 formats).

(5) The multi-technology contactless smart card reader manufacturer shall provide a full product line of compatible products including readers, readers with integral keypads and, credentials and cards without the need of special programming.

(6) The multi-technology contactless smart card reader manufacturer shall provide global, off-the-shelf availability.

(7) The multi-technology contactless smart card reader shall provide universal compatibility with most access control systems by outputting card data in compliance with the SIA AC-01 Wiegand standard.

(8) Multi-technology contactless smart card reader shall be configurable to provide Clock-and-Data output.

(9) Multi-technology contactless smart card reader shall be configurable to provide secure, bidirectional communication in compliance with v2 of the SIA OSDP (Open Supervised Device Protocol) standard

(10) Multi-technology contactless smart card reader shall allow the reader firmware to be upgraded in the field without the need to remove the reader from the wall through the use of factory-provided Programming Cards.

(11) Multi-technology contactless smart card reader shall allow for secure installation practices through mounting methods utilizing tamper resistant screws.

(12) Multi-technology contactless smart card reader shall provide the ability to transmit an alarm signal via and integrated optical tamper switch if an attempt is made to remove the reader from the wall. The tamper switch shall be programmable to provide a selectable action compatible with various tamper communication schemes provided by access control panel manufacturers. The selectable action shall include one of the following:

(a) The reader open collector line changes from a high state (5V) to a low state (Ground).

(b) During a tamper state, the "I'm Alive" message is inverted.

(13) Multi-technology contactless smart card reader shall provide ability of an on-line "I'm Alive" message so the reader's functional health can be monitored at all times when paired with a compatible access control panel.

(14) The multi-technology contactless smart card reader shall provide customizable reader behavior options either from the factory, or defined in the field through the use of pre-configured command cards. Reader behavior programming options shall include:

(a) Audio/Visual Templates for card reads, proximity enabled, and attack detection.

(b) Velocity Check timing and thresholds

(c) 125 kHz ASK, FSK and PSK configurations and outputs

(d) Optical tamper actions

(e) RF scan delay

(f) Hold Mode

(g) Intelligent Power Management

(h) Key diversifiers

(i) Key rolling

(j) CSN output configuration

(k) Data Model prioritization

(l) Default LED color

(15) Multi-technology contactless smart card reader shall provide the following programmable audio/visual indication:

(a) An audio beeper shall provide various tone sequences to signify: access granted, access denied, power up, and diagnostics.

(b) A high-intensity red/green/blue (RGB) light bar shall provide clear visual status. The light bar shall provide uniform distribution of light eliminating individual bright spots.

(16) Multi-technology contactless smart card reader shall allow the reader firmware to be upgraded in the field to face security threats and enable the potential read of future credential technologies. Both firmware and configuration updates shall be executed via a secure channel created between Java firmware/configuration cards and reader secure element.

(17) Multi-technology contactless smart card reader shall provide the ability for mounting to standard electrical boxes through the use of universal international mounting holes.

(18) Multi-technology contactless smart card reader shall be designed to accept hardware expansion modules that add processing power or communication functionalities, including Bluetooth Low Energy for Mobile ID communication and OSDP for panel communication.

(19) Multi-technology contactless smart card reader will support BLE communication to Mobile Access Configuration Mobile Application running on Android 4.3 and higher. This will enable the following features.

(a) Bluetooth communication Controller Firmware version identification.

(b) Bluetooth communication Controller Firmware update.

(c) Mobile ID Application Brand configuration: HID Global or Assa Abloy

(d) Reader operation modes configuration: “Tap” OR “Twist and Go” OR “Tap” and “Twist and Go”.

(e) Mobile Range and Power Setting configuration for following settings: Tap Range, Twist and Go Range, Transmit Power

(f) Mobile Configuration options can be configured without power cycling reader

(g) Mobile Configuration options can only be modified with secure element based Mobile Admin Card authentication with reader.

(20) Multi-technology contactless smart card reader must support Bluetooth communication to Mobile Device credential. This communication must use Bluetooth Low Energy (BLE) communication and not require paring with mobile devices.

(21) Multi-technology contactless smart card reader must support NFC communication card emulation mode. This communication must only occur with credentials stored via Host Card Emulation or a Secure Element in the mobile device. This communication must not occur via NFC peer-to-peer or Reader/Writer mode.

(22) Multi-technology contactless smart card reader must support the following 2 modes of interaction with BLE credentials:

(a) Tap Mode: The mobile device must be brought very close to or touching the reader (a similar user experience to that observed using Prox cards)

(b) Twist and Go: The mobile device holder must initiate the read by twisting the mobile device in using a sharp 90° rotation in either direction.

l. Multi-technology contactless smart card readers shall provide the following enhanced performance features

m. The multi-technology contactless smart card reader shall provide support for 125 kHz proximity FSK (HID Proximity, AWID) and ASK (EM4102) 125 kHz technology to increase credential technology migration options.

n. The multi-technology contactless smart card reader shall enable user prioritization of High-frequency/High-frequency and High-frequency/Low-frequency credential reads. Technology prioritization shall synchronize a site's credential technology read priority to the access panel configuration while reducing unintended credential reads.

o. The multi-technology contactless smart card reader shall have the ability to provide consistent optimal read range by implementing an auto-tune function that adjusts for manufacturing tolerances to enhance consistency of performance from reader to reader.

p. The multi-technology contactless smart card reader shall be field programmable to provide secure upgrades for migration and extended lifecycle.

q. The multi-technology contactless smart card reader shall be designed as a system to provide optimal read range and read speed for increased access control throughput.

r. The multi-technology contactless smart card reader firmware shall be based on Common Language Infrastructure implemented by a .NET virtual machine complying to ECMA-335 standard. This virtual machine shall execute applications stored in a library. Applications that execute on this virtual machine shall be implemented or revoked without modification of the underlying firmware.

s. The multi-technology contactless smart card reader must have spacer available as optional accessory from reader manufacture to space reader away from metallic surfaces and reduce the impact the metal will have on read range

t. The multi-technology contactless smart card reader utilizes directional BLE antenna enabling long range reading distances of up to 6.6' in correct orientation – in front of the reader and not behind it.

u. Multi-technology contactless smart card reader shall provide enhanced environmental and sustainability features.

(1) The multi-technology contactless smart card reader shall reduce power consumption by as much as 75% through the use of Intelligent Power Management (IPM) technology.

(2) The multi-technology contactless smart card reader shall be manufactured with at least 10% recycled material to provide the potential of LEEDS building credits in new construction projects.

(3) Multi-technology contactless smart card reader shall be fully compliant with Restriction of Hazardous Substances directive (RoHS) restricting the use of specific hazardous materials found in electrical and electronic products. The substances banned under RoHS are lead (Pb), mercury (Hg), cadmium (Cd), hexavalent chromium (CrVI), polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE).

v. Multi-technology contactless smart card reader shall comply with the following 13.56MHz-related standards to ensure product compatibility and predictability of performance:

(1) ISO 15693

(2) ISO 14443A

(3) ISO 14443B

w. Multi-technology contactless smart card reader shall implement the following high security 2.4 GHz and 13.56 MHz applications out-of-box.

(1) Secure Identity Object on Mobile Devices

(2) Secure Identity Object on iCLASS Seos

(3) Secure Identity Object on iCLASS SR

(4) Secure Identity Object on MIFARE Classic

(5) Secure Identity Object on MIFARE DESFire EV1

x. Multi-technology contactless smart card reader shall be suitable for global deployment by meeting worldwide radio and safety regulatory compliance including:

(1) UL294 (US)

(2) cUL (Canada)

(3) FCC Certification (US)

(4) IC (Canada)

(5) CE (EU)

(6) Bluetooth SIG certification

y. Multi-technology contactless smart card reader shall be provided with a full potted assembly.

z. Multi-technology contactless smart card reader shall provide the following typical Mobile ID read ranges:

(1) 6.6’ (2m) reading twist and go SIO on Mobile ID using Bluetooth & Seos

(2) 5.9” (15cm) reading tap SIO on Mobile ID using Bluetooth & Seos

(3) 1.0” (2.5 cm) reading Mobile ID using NFC

aa. Multi-technology contactless smart card reader shall be designed for low current operation to enable contactless smart card migration from most legacy proximity applications without the need to replace existing access control panels and/or power supplies. Contactless smart card power requirements shall be:

(1) Operating voltage: 5 – 16 VDC, reverse voltage protected. Linear power supply recommended.

(2) Current requirements and power consumption:

(a) 107 mA (Standard AVG Current)

(b) 240 mA (Peak Current Draw)

bb. Multi-technology contactless smart card reader shall meet the following physical specifications:

(1) Dimensions: 3.3" x 4.8" x 1.0" (8.4cm x 12.2cm x 2.4cm)

(2) Weight: 7.8 (222g) Pigtail and 7.6oz (216g) Terminal Strip

(3) Material: UL94 Polycarbonate

(4) Plastics: Consist of two-piece design with mounting plate and either separate front bezel and reader body (totaling three-pieces) or combined front bezel/reader body (totaling two-pieces).

(5) Color: Black or Charcoal Gray as approved by the project architect.

cc. Multi-technology contactless smart card reader shall meet the following environmental specifications:

(1) Operating temperature: -13 to 150 degrees F (-25 to 65 degrees C)

(2) Operating humidity: 5% to 95% relative humidity non-condensing

(3) Weatherized design suitable to withstand harsh environments with a rating of IP55 or IP65 per IP Code of International Electrotechnical Commission.

dd. Multi-technology contactless smart card reader cabling requirements shall be:

(1) Cable distance:

(a) Wiegand or Clock & Data: 500 feet (150m)

(b) RS-485 (OSDP): 4000 feet (1200m)

(2) Cable type:

(a) Wiegand or Clock & Data: 5-conductor #22 AWG

(b) RS-485 (OSDP): 4-conductor #24 AWG

(3) Standard reader termination: 18" (0.5m) cable pigtail

(4) Optional reader termination: terminal strip

ee. The multi-technology smart card reader shall be provisioned through secure connections utilizing Trusted Identity Platform'sTM Secure Delivery Infrastructure (SDI) where all cryptographic keys governing system security are delivered with end-to-end privacy and integrity.

ff. The multi-technology contactless smart card reader shall provide a lifetime warranty against defects in materials and workmanship.

gg. Manufacturer: HID Global. Model multiCLASS SE BLE enabled Reader Signo 40, Signo 20 (mullion mounted) or approved equal

6. Access Card

a. The access card shall be a contactless smart card and shall function as an access control card, used with access readers to gain entry to controlled portals and to hold identification information specific to the user.

b. The contactless smart card shall be a passive device, with an operating frequency of 13.56 MHz, and shall meet ISO 15693 and ISO 14443B2.

c. The card shall contain a 64 bit unique serial number.

d. The contactless smart card shall have the following available memory configurations:

(1) 2 Kbits (256 bytes) EEPROM memory configured with 2 application areas.

(2) 16 Kbits (2 Kbytes) EEPROM memory configured with 2 application areas.

(3) 16 Kbits (2 Kbytes) EEPROM memory configured with 16 application areas.

e. Each application area shall contain a unique 64 bit diversified authentication key to reduce the risk of compromised data or duplicate cards. The contactless smart card and card reader shall require matching keys in order to function together. All radio frequency (RF) communication between card and reader shall be encrypted, using a secure algorithm.

f. Optionally, the card may be protected with DES or 3DES encryption algorithms through the use of an HID CR400 or CP575A Programmer.

g. Optionally, custom keys uniquely matched to individual sites or customers may be used to provide a non-interchangeable, high level of security.

h. Wiegand card data, up to 84 bits in length, shall be encoded in Application Area 1 for use with access control systems.

i. The contactless smart card will support programming and updating of custom applications after issue, using an appropriate reader/writer or authorized manufacturer’s enabled reader/writer.

j. Typical contactless smart card read ranges shall be:

(1) 2.0-3.0" (5.0-7.6 cm) with the reader

(2) 16"-18" (40-45 cm) with Long Range Reader

k. The contactless smart card shall meet the following physical characteristics:

(1) Dimensions, per ISO 7810: 2.125" x 3.375" x 0.030" (53.98mm x 85.60mm x 0.76mm).

(2) Weight: 0.20 oz. (5.7 g)

l. Material and construction: PVC card materials. Card surface shall be glossy and of a material compatible with direct to card dye-sublimation or thermal transfer printing. Card construction shall meet durability requirements of ISO 7810.

m. Internal antenna configuration shall allow a single slot punch on the vertical (short) side of card.

n. The card may be marked with an external ID number, either in inkjet or laser-etched numbering that may match the internal programmed ID number. If the external number does not match the internal number, a cross-reference list is provided to detail the internal/external numbering sequences.

o. Optionally, the card may contain a magnetic stripe.

p. Optionally, the card may be printed with custom graphics, may be built to a custom thickness and may contain security and anti-counterfeiting features.

q. Contactless smart card shall meet the following environmental specifications:

(1) Operating Temperature: -40oF to 158oF (-40oC to 70oC)

(2) Operating Humidity: 5% to 95% relative humidity non-condensing.

r. Warranty of contactless smart cards shall be lifetime against defects in material and workmanship.

s. Manufacturer: HID. Part No. 200X Series or approved equal.

J. Electrified Door Hardware (FBO)

1. All electrified door hardware/ locksets are to be furnished and installed by others under a separate contract. Electrified locksets will contain an integral Request to Exit switch. Security contractor to provide interconnection of electrified door hardware to the access control system and to the Class E fire alarm system. Provide interconnectivity to the Class E fire alarm system where required. Refer to the door and door hardware specifications and schedule.

K. Request To Exit Passive Infrared Detector

1. Passive infrared detector designed for request to exit applications, with form "C" N.O. contacts rated for 50VDC. Input voltage and current draw, 12-24 VDC/AC; 26 mA.

2. When motion sensor is used with electric strike or electric lock set, the motion sensor shall function as a shunt device for all doors fitted with electrical strikes or electric lock sets. The motion sensor shall not activate the electrical strike or electric lock set.

3. When motion sensor is used with electromagnetic lock, the motion sensor shall deactivate electromagnetic lock. The motion sensor shall not be used as the sole request to exit device for doors equipped with electromagnetic locks.

4. The operating temperature shall be -20 +120 F.

5. Manufacturer: Detection Systems. Part No. DS150i or approved equal

L. Request To Exit Push Button

1. The unit shall be a general purpose button controlled device for use for request to exit applications with engraved “PUSH TO EXIT”.

2. The unit shall be able to be mounted to mullion.

3. Momentary, latching and time delay relay with hold time 0-30 sec. shall be available.

4. The unit shall include DPDT contacts rated a minimum of 5 amp.

5. Manufacturer: Securitron, Part No. PB4N or approved equal. Coordinate finish with Architect.

M. Desk Panic Alarm

1. The unit shall be a surface mount device designed for concealed desk application. The unit shall have SPDT contacts and a latching LED.

2. Manufacturer: Sentrol. Part No. 3040 or approved equal.

2.5 VIDEO INTERCOM SYSTEM

A. General:

1. Installed separately from conventional general-purpose internal communications systems, the IS system shall be used as a video door entry system, emergency announcement system, rescue assistance system, urgent call system, public announcement system, and access control system as scheduled, indicated or required.

2. The system shall be comprised of multiple control units and/or IP direct masters and video door stations. Sub stations shall be installed in multiple locations as scheduled, indicated or required for complete installation.

3. The control unit shall have an add-on feature that permits customization by plugging in additional control units directly or through the network.

4. A full range of control unit functions, including basic conversation, shall be capable: call forwarding, scan monitoring, emergency call, priority call, video audio recording, paging, and zone paging as scheduled, indicated or required.

5. Types of sub stations: vandal resistant, handset indoor use, flush mount, and surface mount types as scheduled, indicated or required.

6. The IS system can be used in combination with CCTV, access control, an emergency broadcast system, scheduled chime distribution system, or other security equipment. This creates a more effective security communication system and ensures a higher level of safety, security, and convenience in each application.

B. System Capacity: Refer to schedule and drawings for required components.

1. 20 Master stations.

2. 20 Video Door stations.

3. 120 Audio or room sub stations.

4. 28 Paging outputs.

5. Chime source inputs.

6. LAN.

C. System Capability:

1. Video, Audio, and Data Logging:

a. PC archives.

b. Record video and audio from door stations.

2. Master Station Flexibility:

a. Pan-tilt zoom and wide video monitoring function.

b. Master station with 3.5 inch display for operation and video monitoring.

c. Hands-free or handset audio communication.

3. Outside Line Communication:

   a. One telephone line, call transfer to up to three telephone numbers.

   b. Door and room sub stations to outside telephone line communication.

4. Internal Audio file for prerecorded message announcement or notification:

   a. Up to 15 audio files can be uploaded to the system.

   b. Up to 20 sequences per day for scheduled announcement.

5. External Audio Input:

   a. Multiple activation inputs with 2 audio inputs for external source distribution.

6. Audio Distribution Scheduling:

   a. Up to 1 year scheduling for calendar schedule.

   b. Up to 20 daily events can be programmed.

   c. Individual scheduled activation can also be set one time or daily.

D. System Functions:

1. Call-Related Functions:

   a. Video Door Station Call: A designated group of up to 20 master stations can be called from any video door station; any designated master can answer the call. 170 degrees view from the door station camera can be viewed from the master station, and zoom and pan/tilt operations are functional.

   b. Sub Station Call: A designated group of up to 20 master stations can be called from any substation; any designated master can answer the call. External speaker and emergency call button can also be added.

   c. Group Call/All Call: A designated group of up to the full capacity of the system with any mix of master stations and door stations can be called from a master station. System needs to be pre-programmed to function.

2. Transfer-Related Function:

   a. Call (Communication) Transfer: A master station can transfer a conversation to any master station within the system.

3. Call Forwarding-Related Functions:

   a. Call Forwarding: Incoming calls can be automatically forwarded to another receiving station or telephone. The receiving station number or telephone number can be registered at the original forwarding station. Unit number will be assigned to each telephone number.

   b. Time-Based Call Forwarding: All incoming calls to the original station can be automatically rerouted to a designated master station or telephone number during a specific period of the day.

   c. No Answer Call Forwarding: Calls to the original station are automatically rerouted to a designated receiving station if the called party does not respond within a preset period of time.

4. Monitoring-Related Functions:

   a. Monitoring: Any door, room or substation can be monitored from a master station. A master station can also disable this function if monitoring is not necessary.

   b. Scan Monitoring: Any pre-programmed door stations or room sub stations (Maximum 20) can be scan monitored.

5. Paging-Related Functions:

   a. Zone Paging: Permits paging to up to 99 individual zones (01-99), established by combining multiple master stations, door stations, and room sub stations with or without public address system equipment. Up to five zones can simultaneously be selected.

   b. Pre-Recorded Audio File Paging: Pre-recorded audio file or outside sound sources can be distributed to pre-programmed paging zones.

6. Priority Call-Related Functions:

   a. Priority Call: Any call from the master station or substation can be pre-programmed with priority level based on normal call, priority call, and urgent call. Urgent call will have the highest priority within individual calls.

   b. Emergency Paging: Emergency paging calls can be made to pre-programmed paging zones. Emergency paging will have the highest priority level. Paging can also be pre-programmed with priority level based on normal call, priority call, and urgent call. Urgent call will have the highest priority.

7. Telephone-Related Functions:

a. Outgoing Telephone Calls: Outside telephone lines can be connected to the IS system, permitting calls from room subs and doors to be forwarded to an outside telephone line.

b. Pre-Recorded Audio File Paging Via Telephone: Pre-recorded audio file can be distributed to programmed paging zones or stations via the telephone.

c. Time-Based Outside Line Call Forwarding: Three telephone numbers can be pre-programmed to be forwarded if the called party does not respond within a preset period of time.

8. Scheduled Pre-Recorded Audio File Paging:

a. Scheduled Paging and Bell: Paging or bell schedules can be programmed onto daily, weekly or yearly calendar.

E. Control Unit:

1. Central Control Unit.

a. Power Source: 48V DC (supplied from Power supply unit).

b. Current Consumption: Maximum 800 mA.

c. Master Stations: Maximum 4.

d. Video Door Stations/ Audio Door Stations/ Room Sub Stations: Maximum 4.

e. Add-on Control Unit: Maximum 2.

f. Room Sub Control Unit: Maximum 4.

g. IP Control Unit: Maximum 1.

h. Video Output: NTSC and BNC (Video channel 1,2).

i. Setting LAN: Ethernet (10 BASE-T).

j. Talk Channels / Video Channels: Local system: 2 talk and 2 video channels, 1 chime.

k. Mounting: Rack-mount (19-inch, 2U rack).

l. Mounting: Wall mount.

m. Ambient Temperature: 0 to 40 degrees C (+32 degrees F to +104 degrees F).

n. Material: Steel plate.

o. Color: Black.

2. Add-on Control Unit. (not required)

a. Power Source: 48V DC (supplied from Power supply unit).

b. Current Consumption: Maximum 1.2 A.

c. Talk Channels / Video channels: Local system: 2 talk and 2 video channels, 1 chime.

d. Master Stations: Maximum 8.

e. Video Door Stations/ Audio door stations/ Room substations: Maximum 8.

f. Video output: NTSC and BNC (Video channel 1,2).

g. Mounting: Rack-mount (19-inch, 2U rack).

h. Mounting: Wall mount.

i. Ambient Temperature: 0 to 40 degrees C (+32 degrees F to +104 degrees F).

j. Material: Steel plate.

k. Color: Black.

F. Color Monitor Master Station:

1. Power Source: Supplied from Central control unit or Add-on control unit.

2. Call Tone: Audible indication and LED blinking (until call timeout).

3. Communication:

a. Handset: Simultaneous Communication (When press-to-talk (PTT) is not set).

b. Hands-free: Auto-voice actuation (VOX) or Press-to-talk (PTT).

4. Monitor: 3.5 inches (89 mm) color LCD monitor.

5. Call Record: 20.

6. Reception Record: 20.

7. Paging Capacity: Simultaneous paging to Maximum 5 zones/stations.

8. Mounting: Desktop use, with stand.

9. Ambient Temperature: 0 to 40 degrees C (+32 degrees F to +104 degrees F).

10. Electrical Box: 1 gang box, for wiring only, unit fixed to the wall directly.

11. Electrical Box: 3 gang box, for wiring and fixing the unit.

12. Housing: Flame resisting ABS resin.

13. Color: Black.

G. Door Station:

1. The unit shall be Vandal Resistant Video Door Station - Surface Mount that meets the following specifications:

a. Power Source: Supplied from Central control unit or Add-on control unit.

b. Type of Communication: Open voice hands-free communication.

c. Camera: 1/4 inch (6 mm) color CMOS.

d. Minimum Illumination: 5 Lux.

e. Camera Angle: Wide, approximately 170 degrees (Horizontal).

f. Ambient Temperature: -10 to 60 degrees C (+14 degrees F to +140 degrees F).

g. Mounting: Surface wall mount (Directly to wall).

h. Material, Front panel: Aluminum, die cast.

i. Main Unit: Flame resisting PC and ABS resin.

j. Color, Front Panel: Dull-gray silver.

k. Description: Weather-resistant.

2. (NOT REQUIRED) The unit shall be a Vandal Resistant Video Door Station - Flush Mount that meets the following specifications:

a. Power Source: Supplied from Central control unit or Add-on control unit.

b. Communication: Open voice hands-free communication.

c. Camera: 1/4 inch (6 mm) color CMOS.

d. Minimum Illumination: 5 Lux.

e. Camera Angle: Wide, approximately 170 degrees (Horizontal).

f. Ambient Temperature: -10 to 60 degrees C (+14 degrees F to +140 degrees F).

g. Mounting: Flush mount.

h. Electrical box: Not used (Mounts on built-in back box).

i. Material, Front Panel: Stainless steel.

j. Color, Front Panel: Silver/Stainless steel, vertical hair-line processed.

k. Color, Back Box: Black.

l. Main Unit: Flame resisting PC and ABS resin.

m. Description: Weather-resistant.

H. Power Supply:

1. Power Source: AC 100 - 240V, 50/60Hz.

2. Power Consumption: 120W.

3. Secondary Output Voltage: DC 48V.

4. Secondary Output Current: 2.1 A.

5. Mounting: Desktop.

6. Mounting: Rack-mount (IS-Rack).

7. Material: Steel plate.

8. Color: Black.

9. Ambient Temperature: 0 to 40 degrees C (+32 degrees F to +104 degrees F).

I. Manufacturer: Aiphone. Models:

1. IS-IPMV – master station

2. IS-IPDV – door station

3. RY-IP44 – power supply

4. IS-CCU – Central Control Unit

5. Or approved equal

PART 3 – EXECUTION

3.1 MAINTENANCE DATA AND OPERATING INSTRUCTIONS

A. Description

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

2. Contents: Prepare a Table of Contents for each volume, with each Product or system description identified, in three parts as follows:

   a. Part 1: Directory; listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractors, and major equipment suppliers.

   b. Part 2: Operation and maintenance instructions arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers.

3. Identify the Following:

   a. Significant design criteria.

   b. Equipment Tests

   c. Parts list for each component.

   d. Operating instructions.

   e. Maintenance instructions for equipment and systems.

   f. Project documents and certificates, including the following:

      (1) Shop drawings and product data.

      (2) Card reader and door contacts open and close reports.

      (3) List of all active devices (card reader, contacts, motion detectors, glass break detectors).

      (4) Certificates.

      (5) Photocopies of warranties.

   g. Photocopies of bonds.

B. Contents, Each Volume

1. Table of Contents: Provide title of project; names, addresses, and telephone numbers of Architect/Engineer, Sub-consultants and contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.

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

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

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

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

C. Warranties: One year on all parts and equipment.

D. Manual for Equipment and Systems

1. Each item of Equipment and Each system: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and test, and complete nomenclature and model number of replaceable parts.

2. Include color-coded wiring diagrams as installed.

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

4. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and troubleshooting, disassembly repair, and reassembly instructions, and alignment, adjusting, balancing, and checking instructions.

5. Provide servicing schedule for all recording equipment.

6. Include manufacturers printed operation and maintenance instructions.

7. Include sequence of operation by controls manufacturer.

8. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required.

9. Provide control diagrams by controls manufacturer as installed.

10. Provide list of original manufacturers; spare parts, current prices, and recommended quantities to be maintained in storage.

11. Include test reports as specified in Section 3.06, Testing.

12. List additional requirements specified in individual Product specification sections.

13. Provide a listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.

E. Instruction of Owners Personnel

1. Before final inspection, instruct Owner's designated personnel in operation, adjustment and maintenance of products, equipment, and systems, at agreed upon times.

2. For equipment requiring seasonal operation, perform instruction for other seasons within six months.

3. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

4. Prepare and insert additional data in Operation and Maintenance manual when needed as the need for such data becomes apparent during instruction.

F. After all final tests and adjustments have been completed, fully instruct the proper Owner's Representative in all details of operation for equipment installed. Supply qualified personnel to operate equipment for sufficient length of time to assure that Owner's Representative is properly qualified to take over operation and maintenance procedures. Supply qualified personnel to operate equipment for sufficient length of time as required to meet all governing authorities in operation and performance tests.

G. Furnish required number of manuals, in bound form containing data covering capacities, maintenance of operation of all equipment and apparatus. Operating instruction shall also include the following:

1. List of Spares: Recommended for normal service requirements.

2. Parts List: Identifying the various parts of the equipment for repair and replacement purposes.

3. Instruction Books may be standard booklets but shall be clearly marked to indicate applicable equipment.

4. Wiring Diagrams: Generalized diagrams are not acceptable; submittal shall be specifically prepared for this Project.

H. Where applicable, one set of operating and maintenance instructions shall be neatly framed behind glass and hung adjacent to the equipment concerned.

3.2 GENERAL REQUIREMENTS

A. Installation shall include the delivery, storage, setting in place, fastening to the building structure, interconnection of the system components, alignment, adjustment and all other work, whether or not expressly specified which is necessary to result in a tested and operational system.

B. All installation practices shall be in accordance with, but not limited to, the specifications and drawings. Installation shall be performed in accordance with the applicable standards, requirements and recommendations of the National Electrical Code and any authorities having jurisdiction.

C. During the installation and up to the date of final acceptance, the Contractor shall be under obligation to protect his finished and unfinished work against damage or loss. In the event of such damage or loss, he shall replace or repair such work at no cost to the Owner.

D. All equipment shall be firmly secured in place unless requirements of portability dictate otherwise. Fastenings and supports shall be adequate to support their loads with a safety factor of at least three.

E. All boxes, equipment, etc., shall be plumb and square. The Contractor must take such precautions that are necessary to prevent and guard against electromagnetic and electrostatic hum, to supply adequate ventilation and to install the equipment to provide reasonable safety for the operator.

F. In the installation of equipment and cables, considerations shall be given not only to operational efficiency, but also to overall aesthetic factors.

G. Electrical work should be installed to specifications. All security wiring shall be concealed or in conduit as noted.

H. Supply and install all fittings and accessories, required for proper, safe and reliable operation of the system whether or not they are specified.

I. No exposed equipment shall be installed without the Architect/Engineer's approval of design, finish and mounting details.

3.3 CABLE INSTALLATION

A. All circuits shall be protected to avoid interruption of service due to short-circuiting or other conditions that might adversely affect the connected devices. Each individual signaling circuit shall be classified as a circuit pair.

B. All cabling run in ceiling cavities shall be neatly strapped, dressed and adequately supported every 8-10 feet. Cable installation shall conform to good engineering practices and to the standards of the most current National Electrical Code.

1. Cables shall be terminated with the proper connector required for the associated operation of the equipment to which it is connected. Screw terminal blocks shall be furnished for all cables that interface with racks, cabinets, consoles or equipment modules. Wire shall be interfaced with screw terminal blocks through the use of spade lugs installed on the cable with an installation tool specifically recommended by the manufacturer of the lug. Evidence of the installation of cables and wires without the appropriate connectors, spade lugs and tools shall be sufficient cause for rejection of the work and reinstallation of the cables or wires.

2. Where cables or wires require soldering, the soldering shall be done using rosin core solder and controlled temperature soldering equipment. Evidence of solder joints not made with rosin core solder or with non-temperature controlled tools shall be sufficient cause for rejection of the work and resoldering of all connections.

C. Every cable or wire shall be labeled or coded at each end. Each terminal of each field terminal strip shall be permanently labeled or coded to show the zone, instrument or item served. Terminal blocks shall be numbered by circuit pairs, such as 1 to 25, 26 to 50, etc.

D. All cables within a rack, console or junction box shall be grouped according to the signals being carried to reduce signal contamination. Separate groups should be formed for the following:

1. Power cables.

2. Video cables and audio cables carrying signals less than 2.0 volts, peak-to-peak.

3. Audio cables carrying signals between 2.0 volts and 24 volts, peak-to-peak, security monitoring cables carrying signal under 5 volts, peak-to-peak.

4. Audio cables carrying signals above 24 volts, peak-to-peak, and local control system cables carrying signals under 24 volts, current limited to under 5 amperes.

E. All security cables shall be in conduit if routed through an exposed ceiling. Under no circumstances shall cables be exposed in the finished area.

F. Coaxial cables shall be run in continuous lengths except for terminations. No splices shall be permitted in any conduit run.

1. All coaxial cables shall be terminated with “BNC” twist-on type. Connector crimp type connectors are not acceptable.

2. Provide Cambridge connectors or approved equal.

3. Install all wiring in such a fashion to avoid interference from electrically induced interference.

G. All conduit support shall be as required.

H. Shielded conductors shall be installed in separate steel conduits and shall not occupy the same enclosure with unshielded conductors. Shielded conductors may be grouped together.

I. Where shielded conductors enter a panel or enclosure, and where power wiring exists, provision shall be made to provide physical isolation of signal and power conductors. Install sleeve on shield grounds in panels. Conduit connections shall be made to assure no interaction between power and signal circuits.

1. Electrical self-stripping tap and pigtail connectors shall be tin plated brass "U" element contact. Connectors shall be 3M Brand Scotchlok 567 to 577.

3.4 GROUNDING

A. A single system ground point shall be established for the system. This shall consist of a single grounding point to which all grounds shall be connected.

B. The system ground shall be located in the base of the security equipment racks. It shall consist of copper bar sufficient in size to accommodate the required grounds.

C. The system ground is to be connected to the local ground bus by conductors that have not more than 0.1 ohm total resistance. Under no conditions shall AC neutral either in a power panel or in receptacle outlets be used for a reference ground.

D. The Contractor shall provide R.F. shielding and R.F. filtering for all systems and components to ensure no interaction with potential R.F. systems in proximity to the site.

3.5 FINISHES

A. Equipment finishes shall be manufacturer's standard unless otherwise noted in the specification. All finishes, whether standard or custom, shall be submitted to the Architect/Engineer for approval prior to fabrication.

3.6 TESTING

A. When the Contractor has completed his own system tests and when the system record documents, including drawings, operation and maintenance manuals, are complete, the Architect/Engineer and the Construction Manager is to be notified that the system fulfils the specifications and is ready for acceptance testing.

1. Contractor shall provide written documentation describing the total system test methodology for review and approval prior to commencement of system test including:

a. Remote devices including door contacts, card readers, door hardware, multiplex panels and all related remote security devices.

b. Communications system including intercom and video intercom components.

c. Power supplies.

d. Panic alarm system including glass break sensors, sirens, panic buttons and all related security devices.

2. Contractor shall provide a minimum of (3) qualified personnel during the test period.

a. Contractor shall provide the required test equipment to perform a complete systems test.

B. Approved English software packages shall be entered into the security computer systems and be debugged. The contractor shall have the responsibility of documenting and entering the initial database into the system. The contractor shall provide the necessary blank forms with instruction to the owner to fill-in all the required data information that will make up the database. The database shall then be reviewed by the contractor and entered into the system. A copy of the document and a copy of the recorded database on a diskette shall be made available for review on a later date. Prior to full operation, a complete demonstration of the computer real-time functions shall be performed in the presence of the Owner, the Architect/Engineer and the Construction Manager. A printed validation log shall be provided as proof of operation for each software application package. In addition, a point utilization report shall be furnished listing each point, the associated programs utilizing that point as an input or output and the programs which that point initiates.

C. Upon satisfactory on-line operation of the system software, the entire installation including all subsystems shall be inspected. The Contractor shall perform all tests, furnish all test equipment and consumable supplies necessary and perform any work as required to establish performance levels for the system in accordance with the specifications. Each device shall be tested as a working component of the completed system. All system controls shall be inspected for proper operation and response. The scope of the inspection work shall include, but not be limited to, the following:

D. Document all measured values and control settings for the system. These values and settings shall be recorded in the operation and maintenance manuals and shall be made available at the time of acceptance testing, following the indicated testing procedures.

E. Check each system including all inputs and outputs for compliance with the performance standards.

1. Test shall demonstrate the specified response time of card readers during simulation of specified maximum access control request load on system.

2. Function all remote sensors for proper operations and testing of all wiring. The test shall include operating each device as it should operate in normal usage. No operations are to be simulated for this test.

3. Check each control and monitoring function from all origination points to all controlled locations for proper operation.

4. Adjust each piece of equipment as required for optimum quality and to meet the manufacturer's published specifications.

5. Check to insure that all systems are free from spurious oscillation and radio frequency pickup both in the absence of any input signal and also when the system is driven to full output.

6. Establish tentative normal settings for all systems controls. All setup controls shall be adjusted for optimum system performance and shall be marked for reference.

7. Demonstrate the power-up and power-down procedure for each system. These procedures shall be documented and then incorporated into the systems operation manual.

F. All tests shall be documented by the Contractor and shall be witnessed by the Owner, the Architect/Engineer and the Construction Manager. Following the system test and inspection, the Construction Manager shall prepare a list of any outstanding work, which must be completed by the Contractor prior to issuance of the certificate of substantial completion.

G. Upon receipt of the Contractor's notice that all punch list items from previous inspections are complete, the Architect/Engineer shall reinspect the work for final acceptance. The Contractor shall provide all test equipment, materials and personnel as required to assist in final acceptance. The final acceptance test shall consist of the following:

1. The Contractor shall verify that all record documentation is complete.

2. The operation of all system and equipment shall be demonstrated by the Contractor to comply with the contract documents. Both subjective and objective tests may be required by the Owner and the Architect/Engineer to determine compliance with the specifications.

H. Upon completion of the reinspection, the Architect/Engineer shall either accept the system as being substantially complete or advise the Contractor of work not completed or obligations not fulfilled as required for final acceptance. If necessary, the entire procedure shall be repeated.

I. The inspections and tests may be suspended at the option of the Architect/Engineer if it is his opinion that major components of the system are defective. The Contractor shall have personnel available at the job site to make adjustments and repairs and take corrective action during the tests.

J. The system shall be accepted as complete when all base contract work has been completed and all remedial work is performed and all documentation is complete, accurate and accepted, and the Owner's personnel has received the specified training.

K. Complete logs of tests shall be retained by the Contractor for inspection and review at any time after the testing has started. Upon final completion of system tests the log records shall be submitted.

L. Submit detailed test checklist and descriptive methodology for approval at least 4 weeks prior to start of test.

M. Field Tests:

1. Complete field tests shall be performed on all sub-systems. Each individual function shall be tested and proven correct in function and response a minimum of two times with not less than two month time between individual tests.

2. Provide the services of fully qualified technicians. Tests shall be performed after the system is adjusted and operating in accordance with specification requirements.

3.7 EQUIPMENT IDENTIFICATION

A. Each major piece of equipment shall be provided with a permanently engraved or embossed metal identification tag. The tag shall include the following information:

1. Name of manufacturer

2. Manufacturer's equipment description

3. Serial number and model number

4. Voltage and current rating

END OF SECTION

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SECTION 31 61 00 - FOOTINGS

PART 1 - GENERAL

1.1 GENERAL

Work of this Section shall conform to requirements of Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections.

1.2 SCOPE

The work covered by this Section shall include all labor, material, equipment, permits, engineering and other services necessary for the fabrication and installation of footings and related work, complete, in accordance with the Drawings and as specified herein.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

Submittals	Division 1
Quality Control	Division 1
Quality Assurance: Structural Testing and Inspection	Section 01 45 00
Concrete Reinforcement and Embedded Assemblies	Section 03 20 00
Cast-In-Place Concrete	Section 03 30 00
Thermal and Moisture Protection	Division 7

1.4 CODES AND STANDARDS

A. Building Code: Footing work shall conform to the requirements of the Building Code identified on the structural General Notes, and OSHA requirements, except where more stringent conditions or criteria occur in the standards referenced below and on the Drawings.

B. Standards:

1. ACI 117 – Standard Specifications for Tolerances for Concrete Construction and Materials.
2. ACI 301 – Standard Specifications for Structural Concrete.
3. ACI 315 – Details and Detailing of Concrete Reinforcement.
4. ACI 318 – Building Code Requirements for Reinforced Concrete.
5. American Concrete Institute “Manual of Concrete Practice”, various committee reports as referenced herein.
6. American Society for Testing and Materials "ASTM Standards in Building Codes", various standards as referenced herein.
7. AWS D1.4 – Structural Welding Code-Reinforcing Steel.

C. Definitions:

1. See Section 03 30 00.
2. The term Owner’s Geotechnical Engineer in this Specification is defined as the Owner’s representative specifically authorized to perform the responsibilities defined herein.

1.5 CONTRACTOR QUALIFICATIONS

A. The Footing Installer shall be a company which specializes in installing footings, with a minimum of 10 years of documented successful experience. Installation shall be performed by skilled workmen thoroughly experienced in the necessary execution.

B. The Contractor's Field Supervisor shall have 10 years of experience in installing footings and provide full-time supervision.

C. The Contractor's Professional Surveyor shall have 10 years of previous experience in laying out foundation locations to perform surveys, layouts, and measurements for footing work. The Contractor's Professional Surveyor shall be licensed in the state where the project is located. Conduct layout work for each footing to lines and levels required before excavation, and actual measurements of each footing's horizontal location, top elevations, deviations from specified tolerances, and other required data.

1.6 SUBMITTALS

A. Required Submittals - Where the SUBMITTALS section of this Specification is in conflict with Division 1 Submittals, the more stringent requirements for the Contractor apply. Required submittal items are listed here; see below for detailed requirements. Do not submit items not requested.

(1) Submittal Schedule
(2) Footing Construction Methods
(3) Installer Qualifications
(4) Shop drawings
(5) Construction Log
(6) Contractor's Survey Report
(7) Submittals required by Related Documents
(8) Mill Certificates
(9) Owner's Concrete Testing Agency Reports
(10) Product Data

1. **Submittal Schedule**: See Section 03 30 00.
2. **Footing Construction Methods**: Submit for record, footing construction procedures developed by the Footing Contractor.
3. **Installer Qualifications**: Submit proof of qualifications as stated in the CONTRACTOR QUALIFICATIONS section of this Specification.
4. **Shop drawings in accordance with 03 20 00 and 03 30 00, and as noted.**

    a) Concrete mix designs in accordance with Section 03 30 00.
    b) Footing reinforcement in accordance with Section 03 20 00 and 03 30 00.
    c) Footing layout drawing showing the location of each footing (with respect to building gridlines), size and depth of footing, and top of footing elevation.

5. **Construction Log**: Testing Agency shall document, sign, and submit for record, a record of each footing construction, including:

a) Footing designation, top and where possible bottom elevation, and size of footing.
b) Size, length, and location of installed reinforcement.
c) Deviation of centerline plan location.
d) Actual allowable soil bearing capacity
e) Inspection and testing
f) Method of concrete placement, time of beginning and ending concrete discharge for each truck, (including any delays in concreting and location of construction joints in shafts) and any deviation from planned construction methods.
g) Volume of concrete supplied to footing and ratio of actual volume to theoretical volume.

6. **Contractor's Survey Report**: Submit for record plans sealed and signed by a Professional Surveyor licensed in the state where the project is located, indicating as built plan locations of footing centerlines (with respect to building gridlines), top and where possible bottom elevations, and identifying deviations of footing centerlines from design plan locations. Footings that are outside of specified tolerances shall be specifically identified on the plan.
7. **Submittals required by Related Documents.**
8. **Mill Certificates**: Per Specification section 03 20 00, submit for record certified reports for physical and chemical properties of following materials:

   a) Reinforcement bars.

9. **Owner's Concrete Testing Agency Reports**: Submit for record

   a) Reports of field observations.
   b) Reports of field quality control tests, as related to concrete and reinforcement.
   c) Immediately notify the Design Professionals of any deviations from the Drawings.

10. **Product Data**: Submit for record for each type of product identified in Part 2. Product Data shall be clearly marked to indicate all technical information which specifies full compliance with this section and Contract Documents, including published installation instructions and ICC reports, where applicable, for products of each manufacturer specified in this section.

B. Submittal Process: See Section 03 30 00.

C. SER Submittal Review: See Section 03 30 00.

D. Substitution Request: See Section 03 30 00.

E. Request for Information (RFI): See Section 03 30 00.

1.7 DELIVERY, STORAGE, AND HANDLING

A. See Sections 03 20 00 and 03 30 00.

1.8 PROJECT SITE CONDITIONS

A. Geotechnical Information: Contractor to examine site, records of test borings, soil samples, and Geotechnical Reports that are available from the Owner. Soil boring test results are provided by the Owner for information, and are not guaranteed to represent conditions that are present at footing locations. Soil boring test results are not intended as representations or warranties of the continuity of the reported conditions. It is expressly understood that the Owner will not be responsible for interpretation or conclusions drawn by Contractor from the Geotechnical Report. At no additional cost to the Owner, evaluate the available data and provide additional test borings and other investigations as necessary for installing footings.

B. Site Survey: Survey of site, existing utilities, and existing construction available from the Owner represent conditions known to Owner. Other obstructions may be encountered.

1.9 QUALITY ASSURANCE BY OWNER'S TESTING AGENCY

A. See Section 01 45 00.

1.10 QUALITY CONTROL BY CONTRACTOR

A. See Section 03 30 00.

B. The Contractor's Geotechnical Engineer shall be qualified to perform the type of work required by the Project. The Engineer shall be a Licensed Professional Engineer in the state where the project is located. The engineer shall develop a site dewatering plan and advise on footing construction techniques, including assistance in the development of construction procedures and the development of solutions to construction problems.

1.11 OBSERVATIONS AND CORRECTIONS BY DESIGN PROFESSIONALS

A. See Section 03 30 00.

1.12 PERMITS AND WARRANTY

A. Permits: See Section 03 30 00.

Drawings and calculations prepared by the Contractor's Licensed Professional Engineer in the state where the project is located for temporary shoring and/or earth retention shall be submitted to the City, State, or other governing authority for review.

B. Warranty: See Section 03 30 00.

PART 2 - PRODUCTS

2.1 CONCRETE

A. See Section 03 30 00.

2.2 REINFORCEMENT

A. See Section 03 20 00.

PART 3 - EXECUTION

3.1 PROTECTION OF EXISTING UTILITIES AND STRUCTURES

A. Before installing footings adjacent to known existing utilities, notify utility owner to ensure that protective work will be coordinated and performed by Contractor in accordance with requirements of the owner of utility or building. If any existing service lines, utilities, and utility structures to remain in service are uncovered or encountered during work, protect the uncovered element from damage and provide support where necessary.

B. Should uncharted or incorrectly charted piping or other utilities be encountered during footing excavation, immediately notify the Owner, Design Professionals and utility owner. Cooperate with Owner and utility owner in keeping their respective services, utilities and facilities in operation. Repair damaged utilities to entire satisfaction of Owner and utility owner concerned.

C. Do not interrupt existing utility service facilities occupied and used by Owner and others, except when permitted in writing by the Design Professionals and then only after acceptable temporary utility services have been provided.

D. Protect structures, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by footing operations.

3.2 SITE DEWATERING

A. Before installing footings, provide site dewatering based on the Contractor's site dewatering plan.

B. Provide and maintain pumping equipment to keep excavations free of water before placing concrete. If excessive water is encountered and drilling operations must be halted, consult the Geotechnical Engineer before using alternate methods of construction.

C. If excessive seepage is coming in from below the bottom of the footing excavation, removal by pumping within the excavation is inappropriate, as this may loosen the bearing soils and reduce the bearing soil capacity; therefore, an alternate means of dewatering will be required.

3.3 GENERAL FOOTING EXCAVATION

A. Tolerances: Plan location tolerance is 2% of footing dimension but no greater than 2 inches (50 mm), whichever is greater, If indicated tolerances are exceeded, see "Footing Corrective Measures" in Part 3.

B. Forming Sides of Footings:

1. Provide forms for footings and grade beams if soil or other conditions are such that earth trench forms are unsuitable.
2. When trench forms are used, provide an additional 1" (25 mm) of concrete on each side of the minimum design profiles and dimensions indicated.

C. Cleanup of Footing Bottom: Excavate bottom to a level plane. Remove loose materials or free water as determined by Owner's Geotechnical Engineer.

D. Bottom of adjacent footings that are at different elevations should never result in an excavation slope between footings greater than 1.0 vertical to 1.5horizontal unless otherwise noted in the drawings or geotechnical engineering report. If steeper slopes occur, the EOR should be notified before any concrete is placed.

3.4 ADDITIONAL EXCAVATION AND FOOTING DEPTH

A. Do not excavate below elevations noted by Owner's Geotechnical Engineer without prior review by Owner's Geotechnical Engineer.

B. Where Owner's Geotechnical Engineer determines that soil encountered at design bearing elevation is not capable of providing minimum design bearing capacity, perform additional excavation as recommended by Owner's Geotechnical Engineer.

C. If obstructions are encountered that interfere with new construction, remove such existing elements or develop corrective methods. The Contractor shall propose corrective actions and their recommendations in writing and submit them for review by the Design Professionals. Efforts shall be made to address obstructions at no additional cost to the Owner.

3.5 DISPOSAL OF EXCAVATED MATERIALS

Dispose excavated materials off site in a manner that will not interfere with other construction activities. Keep construction site at all times clean and free of soil and other debris that could affect progress of other construction activities.

3.6 FOOTING REINFORCEMENT

A. Fabrication in accordance with 03 20 00 from approved shop drawings.

3.7 FOOTING BEARING STRATA

A. Footing Bearing Stratum Criteria and Verification

1. Footings shall be founded on soil strata with bearing capacity indicated on Drawings. Footings shall not be excavated until test results by Owner's Geotechnical Engineer confirm allowable bearing values indicated on Drawings, but shall be excavated immediately thereafter.
2. Each footing bearing strata must be inspected and be acceptable to the Owner's Geotechnical Engineer before placing concrete
3. Footing excavations to acceptable bearing strata shall not be left exposed to weather for more than 48 hours before footing concrete is placed.
4. At no time before or after footing concrete is placed shall the soil below the footing be allowed to freeze. Adequate freeze protection must be sufficient depth to provide adequate frost protection per the geotechnical engineering report.

3.8 CORRECTIVE MEASURES

A. If unforeseen field conditions require corrective installation methods, immediately notify the Design Professionals.

1. Where a change to the construction installation method result in an as-built footing in compliance with the Contract Documents, submit installation method for record.
2. Where the as-built footing does not meet the design intent of the Contract Documents. The Contractor shall propose corrective actions and their recommendations in writing and submit them for review by the Design Professionals.

B. If footings are installed outside allowable tolerances, develop and provide corrective methods at no extra cost to the Owner including calculations based on actual locations of footings, taking into account eccentricity between final centerline of footing and design location of column centerline. The Contractor shall propose corrective actions and their recommendations in writing and submit them for review by the Design Professionals. Calculations shall be sealed and signed by a Professional Engineer licensed in the state where the project is located.

C. Where the Contractor requests that the Design Professionals develop the corrective actions or review corrective actions developed by others, the Design Professional shall be compensated as outlined in Part 3 – CORRECTIVE MEASURES section of Specification 03 30 00.

END OF SECTION

SECTION 321816.13 - PLAYGROUND PROTECTIVE SURFACING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Unitary synthetic seamless surface.

1.2 SUBMITTALS

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

B. Shop Drawings: Show the following:

1. Installation details for curbs, ramps, and accessories.
2. Colors and pattern of surfaces.
3. Location of drainage accessories.

C. Samples: For each type of playground surface system indicated.

D. Product certificates, test reports.

E. Maintenance data.

F. Warranty.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of playground surface system that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Reduction in impact attenuation.
b. Deterioration of surface and other materials beyond normal weathering.

2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Basis-of-Design Product: The design for each product is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 UNITARY SYNTHETIC SEAMLESS SURFACE

A. Seamless Surface: Dual-density, poured-in-place system with wearing course over cushion course. Provide manufacturer's standard thickness for each layer as required for overall thickness indicated, tested for impact attenuation according to ASTM F 1292 and for accessibility according to ASTM F 1951.

1. Products:
   a. GameTime; GT Impax Poured.
   b. Safe Guard Surfacing Corp.; Poured in Place.
   c. Surface America Incorporated; Poured-in-Place

2. Critical Height: Per specified play equipment and component requirements;
3. Overall Thickness: Not less than as required for critical height required.
4. Primer/Adhesive: Manufacturer's standard primer and weather-resistant, moisture-cured polyurethane adhesive suitable for unit, substrate, and location indicated.
5. Wearing Course Color(s): Provide 3 colors as selected by Architect from manufacturer's full range.

   a. Color Pattern: As indicated on Drawings.

6. Filler/Sealant: Manufacturer's standard clear silicone or polyurethane filler/sealant suitable for exterior use.

B. Leveling and Patching Material: Portland cement-based grout or epoxy- or polyurethane-based formulation suitable for exterior use and approved by playground surface system manufacturer.

2.3 GEOSYNTHETICS

A. Drainage/Separation Geotextile: Nonwoven, needle-punched geotextile, manufactured for subsurface drainage applications and made from polyolefins or polyesters; complying with ASTM D 4759 and referenced standard test methods.

B. Molded-Sheet Drainage Panel: Prefabricated, composite drainage panels made with drainage core and filter fabric.

C. Weed-Control Barrier: Composite fabric geotextile consisting of woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, weighing not less than 4.8 oz./sq. yd. (160 g/sq. m).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Prepare substrates to receive surfacing products according to playground surface system manufacturer's written instructions. Verify that substrates are sound and without high spots, ridges, holes, and depressions.

B. Install geosynthetics according to playground surface system manufacturer's and geosynthetic manufacturer's written instructions.

C. Seamless Surface: Mix and apply components of playground surface system according to manufacturer's written instructions. Prevent traffic over system for not less than 48 hours after installation.

1. Edge Treatment: Extended surface course.

END OF SECTION 321816.13

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Chain-Link Fences: commercial.
2. Gates: swing.

1.2 SUBMITTALS

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

B. Shop Drawings: Show locations, components, materials, dimensions, sizes, weights, and finishes of components. Include plans, gate elevations, sections, details of post anchorage, attachment, bracing, and other required installation and operational clearances.

1. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.

C. Samples:

1. Polymer-coated steel wire for fabric.
2. Polymer coating on framing and accessories.

D. Maintenance Data: For polymer finishes.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. UL Standard: Provide gate operators that comply with UL 325.

C. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators serving as a required means of access.

D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. General: Height indicated on Drawings, limited to 6 feet. Comply with ASTM A 392, CLFMI CLF 2445, and requirements indicated below:

1. Steel Wire Fabric: Metallic polymer-coated wire with a diameter of 0.192 inch (4.88 mm).

a. Mesh Size: 1-1/4 inches.
b. Metallic (Zinc) Coating: ASTM A 392, Type II.
c. Polymer Coating: ASTM F 668, Class 2b over metallic-coated steel wire.

1) Color: Black, complying with ASTM F 934.

2. Selvage: Knuckled at both selvages.

2.2 INDUSTRIAL FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, ASTM F 1083 for Group IC round pipe, and the following:

1. Group: IA, round steel pipe, Schedule 40.
2. Fence Height: 4 feet, 6 feet
3. Strength Requirement: Light industrial according to ASTM F 1043.
4. Horizontal-Slide Gate Post: According to ASTM F 1184.
5. Coating for Steel Framing:

a. Metallic coating.
b. Polymer coating over metallic coating.

6. Aluminum Finish: Mill finish complying with ASTM B 429.

2.3 TENSION WIRE

A. General: Provide horizontal tension wire at top and bottom of fence fabric.

B. Metallic-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire complying with ASTM A 817 and ASTM A 824.

1. Metallic Coating: Type III, Zn-5-Al-MM alloy.

2.4 INDUSTRIAL SWING GATES

A. General: Comply with ASTM F 900 for single swing gate types.

1. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F 1083 and ASTM F 1043 for materials and protective coatings.

B. Frames and Bracing: Fabricate members from round, galvanized steel tubing with outside dimension and weight according to ASTM F 900 and the following:

1. Gate Fabric Height: 2 inches (50 mm) less than adjacent fence height.
2. Leaf Width: 36 inches (914 mm).
3. Frame Members:

a. Tubular Steel 2 inches (50 mm)

C. Frame Corner Construction:

1. Welded and 5/16-inch- (7.9-mm-) diameter, adjustable truss rods for panels 5 feet (1.52 m) wide or wider.

D. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet (1.52 m) wide. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

2.5 FITTINGS

A. General: Comply with ASTM F 626.

B. Finish:

1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. (366 g /sq. m) zinc.
2. Aluminum: Mill finish.

2.6 CAST-IN-PLACE CONCRETE

A. Materials: Portland cement complying with ASTM C 150, Type I aggregates complying with ASTM C 33, and potable water.

1. Concrete Mixes: Normal-weight concrete air entrained with not less than 3000-psi (20.7-MPa) compressive strength (28 days), 3-inch (75-mm) slump, and 1-inch (25-mm) maximum size aggregate.

2.7 FENCE GROUNDING

A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Copper
2. Material on or below Finished Grade: Copper.

3. Bonding Jumpers: Braided copper tape, 1 inch (25 mm) wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Connectors and Grounding Rods: Comply with UL 467.

2.8 POLYMER FINISHES

A. Supplemental Color Coating: In addition to specified metallic coatings for steel, provide fence components with polymer coating.

B. Metallic-Coated Steel Tension Wire: PVC-coated wire complying with ASTM F 1664, Class 2b.

C. Metallic-Coated Steel Barbed Wire: PVC-coated wire complying with ASTM F 1665, Class 2b.

D. Metallic-Coated Steel Framing and Fittings: Comply with ASTM F 626 and ASTM F 1043 for polymer coating applied to exterior surfaces and, except inside cap shapes, to exposed interior surfaces.

E. Color: Match chain-link fabric, complying with ASTM F 934.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install chain-link fencing to comply with ASTM F 567 and more stringent requirements specified.

B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

D. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment.

E. Line Posts: Space line posts uniformly per manufacturer specifications.

F. Post Bracing and Intermediate Rails: Install according to ASTM F 567. Install braces at end and gate posts and at both sides of corner and pull posts.

G. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing.

H. Top Rail: Install according to ASTM F 567.

I. Bottom Rails: Install, spanning between posts.

J. Chain-Link Fabric: Apply fabric to inside of enclosing framework. Leave 2 inches (50 mm) between finish grade or surface and bottom selvage, unless otherwise indicated.

K. Tie Wires: Attach wire per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

L. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.2 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.3 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1500 feet (450 m).

B. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet (225 m).

1. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location.

C. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

1. Connections: Make connections so possibility of galvanic action or electrolysis is minimized.

D. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

3.4 FIELD QUALITY CONTROL

A. Grounding-Resistance Testing: Engage a qualified independent testing agency to perform field quality-control testing.

END OF SECTION 323113