



PROJECT MANUAL

VOLUME #3 of 3

**ALLEN CO-SCOTTSVILLE HS
ATHLETIC FIELDS & FACILITIES**
Scottsville, Kentucky

OWNER

Allen Co-Scottsville Board of Education
Scottsville, Kentucky

SUPERINTENDENT - Travis Hamby

March 2026
SCB 2459 / BG #25-250

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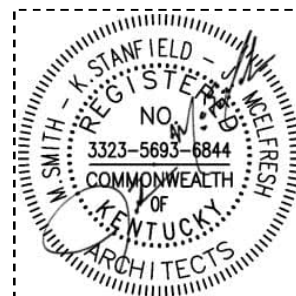


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SCB Project No. 2459

Unless noted otherwise, the following shall apply to all manufacturers listed herein. Subject to compliance with Contract Documents, manufacturers listed are approved as a manufacturer only. This does not imply that specific products supplied by such manufacturers have been reviewed and comply with requirements. It shall be the manufacturer's / contractor's responsibility to ensure that all requirements of the Contract Documents are met.

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- 211000 Water Based Fire Suppression System

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- 220200 Excavation and Backfilling for Underground Piping
- 220517 Sleeving, Cutting, Patching and Repairing for Plumbing
- 220529 Hangers and Supports for Piping and Equipment
- 220548 Vibration and Seismic Controls for Plumbing Piping and Equipment
- 220553 Identification of Plumbing, Piping and Equipment
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- 230100 General Provisions for Mechanical
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- 230529 Hangers and Supports for HVAC Piping and Equipment
- 230530 Metal Fabrications and Structural Steel
- 230548 Vibration and Seismic Controls for HVAC
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230900	Instrumentation and Controls
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233113	Ductwork and Ductwork Insulation
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282300	Video Surveillance System
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284102	Emergency Radio Communications Enhancement System

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312200	Grading
312316	Excavating
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END OF VOLUME 3

SECTION 21 05 48 – VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 – GENERAL

1.1 SUMMARY

- A. This specification includes vibration isolation, equipment balancing requirements and sound level criteria for equipment spaces and exterior mounted equipment.
- B. Mechanical and electrical equipment and associated piping and ductwork shall be mounted on vibration isolators as specified and/or required to minimize transmission of vibration and structure-borne noise to building structure or spaces.
- C. It is the intent of the seismic portion of this specification to keep all mechanical and electrical building system components in place during a seismic event.
- D. All rotating equipment shall be balanced both statically and dynamically. The equipment when mounted and placed in operation shall not exceed a self-excited vibration velocity of 0.10 inches per second in the vertical, horizontal, or axial directions when measured with a vibration meter on the bearing caps or at the equipment mounting feet if the bearings are concealed.
- E. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Elastomeric isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Elastomeric hangers.
 - 5. Spring hangers.
 - 6. Snubbers.
 - 7. Restraints - rigid type.
 - 8. Restraints - cable type.
 - 9. Restraint accessories.
 - 10. Post-installed concrete anchors.
 - 11. Concrete inserts.
- F. Related Requirements:
 - 1. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
 - 2. Section 211000 – WATER BASED FIRE SUPPRESSION SYSTEM
 - 3. Section 220100 - GENERAL PROVISIONS FOR FIRE-SUPPRESSION WORK

1.2 DEFINITIONS

- A. Designated Seismic System: A fire-suppression component that requires design in accordance with ASCE/SEI 7, Ch. 13, and for which the Component Importance Factor is greater than 1.0.

- B. All equipment or systems with a component importance factor of 1.0 [$I_p=1.0$] is referred to as "Life Safety" (stay in place) for equipment that must remain in place during an earthquake without regard to its ability to remain functional, it certifies that the anchoring system for isolated or non-isolated equipment will not fail, and the equipment will not fall onto building occupants or other essential equipment.
- C. All equipment or systems with a component importance factor of 1.5 [$I_p=1.5$] is referred to "Essential" (stay in place and remain operational) for equipment that not only meets the above conditions but must not fail internally or externally. This requires an independent dynamic seismic analysis of the equipment for a Certificate of Compliance and may require modification of the unit by the manufacturer or the system by the contractor. This factor also applies to components containing hazardous materials and to components in or attached to an Occupancy Category IV structure and its failure could impair the continued operation of the facility.
- D. IBC: International Building Code.

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product.
 - 2. Detail fabrication and assembly of equipment bases.
 - 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.
- B. Delegated Design Submittals:
 - 1. For each seismic-restraint device, including seismic-restrained mounting, pipe-riser resilient support, snubber, seismic restraint, seismic-restraint accessory, concrete anchor and insert, and restrained isolation roof-curb rail that is required by this Section or is indicated on Drawings, submit the following:
 - a. Seismic Restraint, and Vibration Isolation Base Selection: Select vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
 - b. 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 by professional engineer that riser system was examined for excessive stress and that none exists.
 - c. Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
 - d. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
 - e. Qualified Professional Engineer: All designated-design submittals for seismic- and wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
 - 2. Seismic Restraint Detail Drawing:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.

- b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.
- 3. All delegated design submittals for seismic-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
- 4. Product Listing, Preapproval, and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and basis for approval (tests or calculations).
- 5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
- 6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for fire-suppression piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For professional engineer and testing agency.
- C. Welding certificates.
- D. Field quality-control reports.
- E. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-10 Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.
 - 1. Provide equipment manufacturer's written certification for each designated active mechanical seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction or experience data as permitted by ASCE/SEI 7-10.
 - 2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-10.
 - 3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.
 - 4. The following fire-suppression systems and components are Designated Seismic Systems and require written special certification of seismic qualification by manufacturer:

- a. Piping and equipment.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-spring isolators and restrained-air-spring isolators to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that require periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an agency acceptable to authorities having jurisdiction.

1.7 WARRANTY AND SERVICE

- A. All equipment shall be warranted for a period of at least one (1) year from the date of acceptance, as evidenced by date of substantial completion for the entire project or for the last phase of the project, whichever occurs later, against defective materials, design, and workmanship. In addition to the equipment warranty, the Contractor shall provide all repair and adjustment service necessary for the proper operation of the entire system for a period of one (1) year after the date of acceptance, as evidenced by the date of substantial completion for the entire project or for the last phase of the project, whichever occurs later. Upon receipt of notice from the Owner's representative of failure of any part of the warranted system or equipment during the warranty period, the affected part shall be replaced promptly with a new part without cost to the Owner. Upon failure to take action within 24 hours after being notified, the work will be accomplished by the Engineer at the expense of the Contractor. See General Conditions and individual equipment specifications. Note that the warranty period of time specified in this section represents the minimum warranty period required for work performed under specification Division 21, 22 and 23. Where the General Conditions and/or individual equipment/system specifications require a warranty period of longer duration or earlier start date than specified in this paragraph, the longer duration/earlier start date shall supersede for those portions of work covered by that specification. In the event the contractor is notified of warranty issues but does not correct or address the warranty issues prior to the end of the specified warranty period, the contractor will not be relieved of the responsibility to correct the deficient items after the warranty end date has passed.
- B. Make a minimum of two (2) service calls during guarantee period, free of charge, to check with Owner and to check and repair malfunctioning equipment which was installed. Service calls shall be in middle and end of guarantee period and as required to maintain systems operation. Dates shall be listed in operating and maintenance manuals, along with contractor's name and phone number.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Mason Industries, Amber/Booth Company, Vibration Elimination Co., Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic load control system.

1. Seismic Performance: Equipment to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7-10.
- B. Consequential Damage: Provide additional seismic restraints for suspended fire-suppression components or anchorage of floor-, roof-, or wall-mounted fire-suppression components as indicated in ASCE/SEI 7-10 so that failure of a non-essential or essential fire-suppression component will not cause failure of any other essential architectural, mechanical, or electrical building component.
- C. Fire/Smoke Resistance: Seismic restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723 and be so labeled.
- D. Component Supports:
 1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
 2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-10 Section 13.6.

2.3 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
 1. Source Limitations: Obtain elastomeric isolation pads from single manufacturer.
 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 3. Size: Factory or field cut to match requirements of supported equipment.
 4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
 5. Surface Pattern: Smooth, ribbed, or waffle pattern.
 6. Infused nonwoven cotton or synthetic fibers.
 7. Load-bearing metal plates adhered to pads.
 8. Sandwich-Core Material: Resilient and elastomeric.
 - a. Surface Pattern: Smooth, ribbed, or waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.4 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts:
 1. Source Limitations: Obtain double-deflection, elastomeric isolation mounts from single manufacturer.
 2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolt.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
 3. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.5 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:

1. Source Limitations: Obtain restrained elastomeric isolation mounts from single manufacturer.
2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - a. Housing: Cast-ductile iron or welded steel.
 - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.6 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Anchor Rods:

1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
2. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.

2.7 SNUBBERS

A. Source Limitations: Obtain snubbers from single manufacturer.

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-14 Ch. 17 for 2015 or 2018 IBC.
2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

2.8 RESTRAINTS - RIGID TYPE

A. Source Limitations: Obtain rigid-type restraints from single manufacturer.

B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.9 RESTRAINTS - CABLE TYPE

A. Source Limitations: Obtain cable-type restraints from single manufacturer.

B. Seismic-Restraint Cables: ASTM A1023/A1023M galvanized cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

- C. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.10 RESTRAINT ACCESSORIES

- A. Source Limitations: Obtain restraint accessories from single manufacturer.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.11 POST-INSTALLED CONCRETE ANCHORS

- A. Mechanical Anchor Bolts:
 - 1. Source Limitations: Obtain mechanical anchor bolts from single manufacturer.
 - 2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.
- B. Adhesive Anchor Bolts:
 - 1. Source Limitations: Obtain adhesive anchor bolts from single manufacturer.
 - 2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
- C. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-10, Ch. 13.
 - 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
 - 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.
- D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 HP that is not vibration isolated.
 - 1. Undercut expansion anchors are permitted.

2.12 CONCRETE INSERTS

- A. Source Limitations: Obtain concrete inserts from single manufacturer.
- B. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.
- C. Comply with ANSI/MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- 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 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICES

- A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Devices Schedules, where indicated on Drawings, or where Specifications indicate they are to be installed on specific equipment and systems.
- B. Provide seismic-restraint devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
- C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- D. Installation of vibration isolators and seismic restraints must not cause any stresses, misalignment, or change of position of equipment or piping.
- E. Comply with installation requirements of NFPA 13 for installation of all seismic-restraint devices.
- F. Comply with requirements in Section 077200 "Roof Accessories" for installation of equipment supports, and roof penetrations.
- G. Equipment Restraints:
 - 1. Install seismic snubbers on fire-suppression equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- H. Piping Restraints:
 - 1. Comply with requirements in NFPA 13.
 - 2. Design piping sway bracing in accordance with NFPA 13.

- a. Maximum spacing of all sway bracing to be no greater than indicated in NFPA 13.
 - b. Design loading of all sway bracing not to exceed values indicated in NFPA 13.
- I. Install seismic-restraint cables so they do not bend across edges of adjacent equipment or building structure.
- J. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- K. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- L. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- M. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- N. Mechanical Anchor Bolts:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 221000 "Fire-suppression Piping and Valves" and Section 221119 "Domestic Water Specialties" for piping flexible connections.

3.5 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

- A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate dimensions of steel equipment rails and bases, concrete inertia bases, and restrained isolation roof-curb rails with requirements of isolated equipment specified in this

and other Sections. Where dimensions of these bases are indicated on Drawings, dimensions may require adjustment to accommodate actual isolated equipment.

3.6 ADJUSTING

- A. Adjust isolators after system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.7 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. Tests and Inspections:
 - 1. Perform tests and inspections with the assistance of a factory-authorized service representative.
 - 2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
 - 4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 5. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
 - 6. Test to 90 percent of rated proof load of device.
 - 7. Measure isolator restraint clearance.
 - 8. Measure isolator deflection.
 - 9. Verify snubber minimum clearances.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Units will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 21 05 48

SECTION 21 10 00 – WATER BASED FIRE SUPPRESSION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This section covers the complete installation of a full wet-pipe protection sprinkler system and related items.
- B. Provide all items, articles, materials, operations and/or methods listed, mentioned, or herein specified, including all labor, materials, equipment, and incidentals necessary and required for their completion.
- C. Design drawings for this project show the location of fire protection system work is required. Any additional system components or sprinkler heads that may be required to meet all NFPA 13 requirements is the responsibility of the contractor. Any areas not shown to be sprinkled but required to be sprinkled by NFPA 13 requirements shall be sprinkled by the contractor and include any and all equipment required.
- D. Contractor shall submit design drawings and calculations to engineer for approval prior to submission to HBC.
- E. All equipment shall be manufactured within 24 months of bid date, no exceptions. Any equipment installed outside of this timeframe shall be removed and replaced to meet this requirement at no additional cost to the owner.

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR PLUMBING WORK
- C. Section 220200 - EXCAVATION AND BACKFILLING FOR UNDERGROUND PIPING
- D. Section 220517 - SLEEVING, CUTTING, PATCHING AND REPAIRING – PLUMBING
- E. Section 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

1.3 WORK INCLUDED

- A. The work covered by this section of the specifications consists of the furnishing of all materials, labor, equipment and appurtenances and the performance of all operations required for the installation of a system of automatic sprinklers.
- B. Work shall commence at a point where shown and shall include all necessary parts, accessories and items of work required for a complete and finished installation including all normally closed flow switches for use by the fire alarm system.
- C. All piping including all valves, sprinkler heads, alarm valve, control valves, etc.
- D. Any apparatus, machinery, material small items or incidentals not mentioned herein, which may be found necessary to complete or perfect any portion of the installation in a substantial manner and in compliance with the requirements stated, implied, or intended in these specifications, shall be furnished without extra cost to the owner. This shall include fire department connections, post indicator valve, water motor gong, ALARM BELL, backflow checks, all electrical power and control wiring and interlock which is not shown on the Electrical Drawings, etc. to provide a complete system and approved fire protection system.

- E. The building areas in general are based on light hazard occupancy with storage rooms and mechanical rooms on ordinary hazard; head spacing as required. A system based on hydraulic calculation, as approved by NFPA 13, is acceptable, and as required by the insuring company. Occupancy hazard shall be confirmed by the local Fire Marshal and/or the authority having jurisdiction before calculations are performed.

1.4 SPECIAL REQUIREMENTS

- A. No Contractor other than those regularly engaged in the installation of approved and franchised automatic sprinkler systems will be considered or approved for the work under this Section of the specifications. Bidders must have had not less than five years' experience in the fabrication and erection of such systems and shall have completed installations similar and equal in scope to this system under approval by one or more of the recognized underwriting associations in the insurance field.
- B. Before submitting bid, examine all mechanical, electrical, architectural, and structural drawings, visit the site, and become acquainted with all conditions that may, in any way whatsoever, affect the execution of this work.
- C. The Contractor shall take his own measurements and be responsible for exact size and location of all openings required for installation of this work. Figured dimensions where indicated are reasonably accurate and should govern in setting out work. Detailed method of installation is not indicated. Sprinkler Contractor shall coordinate exact ceiling grid location and install sprinkler heads centered in the 2' x 2' and 2' x 4' ceiling panels. Location of sprinkler head must be carefully coordinated with the Architect.
- D. It shall be this Contractor's responsibility to verify all existing water line sizes and to conduct water flow tests and report to the Architect and Engineer the results of water flow test. Existing water flow test listed within the bidding documents is for bidding purposes only. The Contractor shall conduct/obtain his own water flow test information for use in shop drawing/hydraulic calculations. Water flow test shall be done in accordance with NFPA 291 and use a minimum of two (2) fire hydrants. The test shall be fully coordinated with the utility company, fire department and owner and witnessed by the Architect/Engineer's representative.
- E. It is not the intent of these Plans and Specifications to provide a complete detailed description of the apparatus, materials, equipment, etc., which is required to make a complete installation of a specified fire protection system. Include all required sprinkler heads, tamper switches, material and equipment and perform all work required to install a complete and approved installation.
- F. All materials and methods shall be in accordance with applicable codes, regulations and/or ordinances and meet approval of local inspection authority and insuring agency having jurisdiction. The latest edition of the National Board of Fire Underwriters Bulletins shall be the minimum requirement for all work. All materials under this Contract shall be listed by the Underwriter's Laboratories, Inc., as approved for fire protection installation. The installation shall comply with the NFPA, and the Kentucky Building Code and Local Fire Marshal in every respect.
- G. Perform work under this section in close harmony with other sections so completed work shall present a neat and workmanlike installation.
- H. All road crossings or excavation and backfill required for the completion of this work shall be a part of this Contract.
- I. Any paving, floors, or other improvements disturbed or destroyed as a result of installation of sprinkler system, shall be restored or replace to Owner's satisfaction.

1.5 STRUCTURAL DRAWINGS AND SPECIFICATIONS

- A. Each Contractor shall refer to the Structural Drawings and Specifications for the general construction of the building, for floor and ceiling heights, for location of walls, partitions,

beams, grade beams, foundations, footings etc., and shall be guided accordingly for the setting of all sleeves and equipment.

- B. Under no circumstances shall a Contractor scale the Drawings for the locations of equipment and work.
- C. The contractor is responsible for reviewing all below slab / underground piping with structural components and coordinating all stepped footings or sleeves where required.

1.6 ACTION SUBMITTALS

A. Shop Drawings:

1. Prepare detailed shop drawings for the complete sprinkler system, showing the location of the heads, piping and other installation details and submit plans to the Architect. Drawings shall bear the stamp of a certified sprinkler technician and shall be complete with all calculations and equipment drawings for approval of Architect, Engineer, and the Department of Housing, Building and Construction and/or the authority having jurisdiction.
2. Sprinklers shall be shown on drawings, submittals and project information and shall be identified by the manufacturer's style or series designation as published in the appropriate agency listing or approval. Trade names and abbreviations are not permitted.
3. Shop drawings and descriptive literature shall be submitted as a minimum, but not limited to the following:
 - a. Sprinkler Heads
 - b. O. S. & Y Valve
 - c. Alarm Control
 - d. Back Flow Preventer Detector Check
 - e. Pipe Hanger and Support
 - f. Post Indicator Valve
 - g. Fire Department Connection
 - h. Fire Hydrants
 - i. Fire Pit/Vault
 - j. Air Compressors
4. Shop drawing shall be submitted to the engineer for review prior to other submittals.
5. Shop drawings shall be submitted to HBC for approval prior to the start of construction.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. For wet-pipe sprinkler systems and specialties to include in operation and maintenance manuals.
2. Complete set of as built "Record Drawings" showing final installation of the work.

1.8 PERMITS, CODES, AND INSTALLATIONS

- A. All construction permits and inspections for the automatic sprinkler system shall be paid for and furnished under this section. The work shall be installed in a manner to comply with all state and local codes applicable and with all requirements of NFPA Standard 13

latest revision for the installation of sprinkler systems. The entire installation, all materials, etc., shall meet their requirements.

- B. Contact the serving Water Company to determine their cost for any tap on fees, vault, valves, piping, equipment required to complete the fire protection tie in. These costs shall be included in this Contract.
- C. Pay for all fees and costs arising from this installation and for any and all destruction to property, both public and private, which may arise from this service tap on.
- D. No work is to be started by the Contractor until Contractor's drawings are approved by the Division of Housing, Building and Construction and the local Fire Marshal's offices, and one copy delivered to the Architect. Entire installation is to be approved by the Division of Housing, Building and Construction, and the local Fire Marshal and/or the authority having jurisdiction. Final payment will not be made until these approvals are received.

1.9 INSURANCE CARRIER REQUIREMENTS

- A. All material shall conform to FME & R requirements.
- B. Underground piping shall have 3.5 ft. of cover minimum.
- C. The sprinkler system shall be hydraulically designed for light hazard requirements except where noted on the drawings. Minimum hose stream shall be 100 gpm applied at the hydrant closest to the user. Design shall use the area/density method. The room design method shall not be used.

1.10 DIGITAL DATA AND FILE TRANSMISSION

- A. Sub-Contractors (SC) requiring digital files to prepare shop drawings and governmental agency submittals shall make their request through the Construction Manager (CM) or General Contractor (GC).
 - 1. The CM/GC shall compile a list of requested drawings from the respective SC's and submit one comprehensive list to STW.
 - 2. STW will provide the CM/GC with a digital file transmission release form. The CM/GC may sign and return or have the requesting SC's sign and return to STW through the CM/GC.
 - 3. After receiving the signed release form, STW will provide one set of all requested digital files to the CM/GC to then distribute to the appropriate SC's.
 - 4. STW will provide AutoCAD/dwg files.
 - a. Revit/BIM models will not be provided to contractors. Projects completed using REVIT will be exported to AutoCAD prior to releasing.
- B. The project architect is the owner/author of the floor plans and reflected ceiling plans.
 - 1. The architect must approve the release of these plans before STW can release our respective drawings.
 - 2. Requests for floor plans and/or reflected ceiling plans only shall be made directly to the architect.

1.11 WARRANTY AND SERVICE

- A. All equipment shall be warranted for a period of at least one (1) year from the date of acceptance, as evidenced by date of substantial completion for the entire project or for the last phase of the project, whichever occurs later, against defective materials, design, and workmanship. In addition to the equipment warranty, the Contractor shall provide all repair and adjustment service necessary for the proper operation of the entire system for a period of one (1) year after the date of acceptance, as evidenced by the date of substantial completion for the entire project or for the last phase of the project, whichever occurs later.

Upon receipt of notice from the Owner's representative of failure of any part of the warranted system or equipment during the warranty period, the affected part shall be replaced promptly with a new part without cost to the Owner. Upon failure to take action within 24 hours after being notified, the work will be accomplished by the Engineer at the expense of the Contractor. See General Conditions and individual equipment specifications. Note that the warranty period of time specified in this section represents the minimum warranty period required for work performed under specification Division 21, 22 and 23. Where the General Conditions and/or individual equipment/system specifications require a warranty period of longer duration or earlier start date than specified in this paragraph, the longer duration/earlier start date shall supersede for those portions of work covered by that specification. In the event the contractor is notified of warranty issues but does not correct or address the warranty issues prior to the end of the specified warranty period, the contractor will not be relieved of the responsibility to correct the deficient items after the warranty end date has passed.

- B. Make a minimum of two (2) service calls during guarantee period, free of charge, to check with Owner and to check and repair malfunctioning equipment which was installed. Service calls shall be in middle and end of guarantee period and as required to maintain systems operation. Dates shall be listed in operating and maintenance manuals, along with contractor's name and phone number.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. All equipment and materials shall be new and approved by the UL and/or NFPA. System design shall be 175 PSIG.
- B. Trade name and manufacturers mentioned herein are intended only to indicate design, quality, and size. Other manufacturers products equal in all respects may be substituted, provided they meet with the prior approval of the architect and are found by him to be equal in every way to the items specified herein.
- C. All devices shall be in accordance with the rules and regulations of the state fire marshal's office in all cases and shall bear the label of approval of the Underwriters Laboratories and/or NFPA.

2.2 ACCEPTABLE MANUFACTURERS

- A. Allied Piping, Firematic, Grinnell, Reliable, Star, Victaulic, Viking, Potter Electric Signal, System Sensor.

2.3 INTERIOR WET SYSTEM FIRE PROTECTION PIPING AND FITTINGS

- A. Schedule 40, Black Steel Pipe: ASTM A135. Pipe ends may be factory or field formed to match joining method. NPS 1 to NPS 2.
- B. Interior piping shall be Allied, or equal, "Lightwall", ASTM-A135, Schedule 10 black steel, assembled with ductile iron grooved bolted, mechanical pipe fittings, ASTM A 536, Series 100 Victaulic, or equal. Joints shall be Victaulic style 75 or equal. NPS 2-1/2 to NPS 8.
 - 1. Grooved joint fittings shall be manufactured of ductile iron, conforming to ASTM A 536; forged steel, conforming to ASTM A 234; or fabricated from carbon steel pipe, conforming to ASTM A 53; with grooved ends conforming to ANSI/AWWA C606.
 - 2. Bulged short pattern fittings may be used in lieu of standard pattern fittings. The fittings shall have a flow rate equal to standard pattern fittings.
- C. Grooved joint couplings shall consist of ductile iron housings, conforming to ASTM A 536, complete with pressure responsive synthetic rubber gasket. (Grade to suit the intended service.)

1. Rigid Type: Coupling housings cast with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with NFPA 13. Couplings shall be fully installed at visual pad-to-pad offset contact. Tongue and recess rigid type couplings shall not be permitted.
 - a. Victaulic Style 005 or engineer approved equal.
 - b. 1-1/4" through 4": Installation-Ready, for direct slab installation without field disassembly or loose parts. Victaulic Style 009-EZ or engineer approved equal.
2. Flexible Type: Use in locations where vibration attenuation and stress relief are required or for seismic applications in accordance with manufacturer's recommendations. Victaulic Style 75 or engineer approved equal.
3. Flange Adapter: Flat face, for direct connection to ANSI Class 125 or 150 flanged components. Victaulic Style 744, 741 or equal.

2.4 EXTERIOR FIRE PROTECTION WATER PIPING AND FITTINGS

- A. Materials specified and used are subject to final approval of the fire marshal and the local water company.
- B. Fire service fittings 2-1/2" and larger shall be cement lined, mechanical joint or grooved end, cast iron water main or PVC pressure in conformance to the latest ASA, ASTM, FS and AWWA specification. Cast iron fittings shall have the manufacturer's standard coal tar on asphaltic base coating outside and a cement lining on the inside, all in accordance with ASA 21.4. Fittings shall be rated at 250 PSI working pressure. PVC piping shall be C-900, 200 PSI rating per local water company standards with tracer wire.
- C. All material shall be FME & R approved.

2.5 SPRINKLER HEADS

- A. All sprinkler heads shall be Underwriter's approved automatic spray semi-recessed sprinklers and/or exposed upright sprinklers of the correct temperature and type for each location unless otherwise noted. Provide a spare head cabinet with one sprinkler wrench. Quantity of extra heads as indicated in NFPA #13.
- B. Stainless steel flexible sprinkler drops may be used to properly locate sprinkler heads. The flexible tube shall be braided (FM-1637) or unbraided/corrugated (UL 2443) type 304 stainless steel. The drops shall be UL listed or FM approved with one-piece open gate bracket for sprinkler installation before or after the bracket is secured to the ceiling gird. Any flexible drop 36-inches or longer must be listed for a minimum of three 90-degree bends to insure proper installation.
- C. Sprinkler heads in gymnasium areas and in areas subject to abuse shall be provided with wire guards.
- D. Sprinkler heads 7' 0" or less above floor and other heads where subject to mechanical injury shall be provided with wire guards.

2.6 SPRINKLER HEAD CABINET

- A. Steel Cabinet with hinged cover designed for wall mounting and having a finished appearance. Cabinet shall hold a minimum of six spare sprinklers plus a sprinkler wrench. Provide number of sprinkler heads required by NFPA 13.

2.7 CONTROL VALVES

- A. All valves 2" and smaller shall be bronze, solid bronze solid ball or wedge disc, screwed or grooved end pattern, ball type or outside rising stem and yoke, designed for 150 psi working pressure and approved by Underwriters Laboratories and Factory Mutual.

- B. All gate valves 2-1/2" and larger shall be iron body, bronze mounted, double disc, parallel seats outside screw and yoke and grooved end, screwed or flanged pattern designed for 160 psi working pressure and approved by Underwriters Laboratories.
- C. All butterfly valves 2-1/2" and larger shall be ductile iron body, elastomer encapsulated ductile iron disc with integrally cast stem, grooved pattern designed for 300 psi maximum working pressure and approved by Underwriters Laboratories.
- D. Valve Operators: Where indicated on drawings, provide UL and FM approved indicator parts.

2.8 CHECK VALVES

- A. Check valves shall be ductile iron body, bronze, or stainless steel mounted, flanged or grooved and Underwriters and Factory Mutual approved for 250 psi or 175 lbs. working pressure.

2.9 ALARM VALVES

- A. Standard: UL 193. Design: For horizontal or vertical installation. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.

2.10 DRAINS

- A. Where drains, flushing connections, etc., are necessary to comply with local code or NBFU requirements, they shall be considered a part of this Contract and furnished and installed accordingly, whether shown specifically on the Drawings or covered in these Specifications.
- B. All sprinkler branch piping shall be installed to drain at main riser wherever possible.
- C. Where sprinkler piping is trapped, an approved auxiliary draw-off shall be provided and installed. Provide all test drains as required. All exposed piping on the exterior of the building shall be rust proofed and painted, color as selected by Architect. Provide splash blocks at all exterior drains.

2.11 INSPECTOR'S TEST STATIONS

- A. Install 1" inspection test connection. Discharge from test connection shall run to open air. All locations must comply with NFPA requirements and local Fire Marshall requirements.
- B. Inspection test connection shall have an attached metal tag bearing the words "Test Connection".

2.12 PRESSURE GAGES

- A. Standard: UL 393. Dial Size: 3-1/2- to 4-1/2-inch diameter. Pressure Gage Range: [0- to 250-psig minimum. Label: Include "WATER" label on dial face.

2.13 ALARMS

- A. Provide the following alarms where required or indicated:
 - 1. Water-Motor Operated Alarms
 - 2. Electronically Operated Alarm
 - 3. Water-Flow Indicator
 - 4. Pressure Switch
 - 5. Valve Supervisory Switch
 - 6. Indicator Post Supervisory Switch

2.14 FIRE DEPARTMENT CONNECTIONS

- A. UL 405, single or Siamese connection as required by the local fire department with brass inlets and threads according to the NFPA 1963 and matching local fire department sizes and threads. Provide with caps, gaskets and chains as required.
- B. Where applicable, install a 90-degree elbow with drain connection at each connection, equal to Victaulic #10-DR.

2.15 FIRE HYDRANTS

- 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. American Cast Iron Pipe Company.
 - 2. Kennedy Valve Company; a division of McWane, Inc.
 - 3. Mueller Co.
- B. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets; and with 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Hydrant shall have cast-iron body and compression-type valve that opens against pressure and closes with pressure.
- C. Standards: UL 246 and FM Global's "Approval Guide."
- D. Design: Base valve.
- E. Pressure Rating: 250 psig.
- F. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
- G. Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
- H. Direction of Opening: Hydrant valve opens by turning operating nut to left or counterclockwise or as required by the local fire marshal or the authority having jurisdiction.
- I. Exterior Finish: Red alkyd-gloss enamel paint unless otherwise indicated.

2.16 WALL AND CEILING ESCUTCHEONS

- A. This contractor shall furnish and install on all lines passing through the floor, ceiling or wall in finished areas, an approved escutcheon as specified in Section 220517 – SLEEVEING, CUTTING, PATCHING AND REPAIRING - PLUMBING. Escutcheons shall be submitted for approval before installation. Standard plates used in the industry may not be acceptable.

2.17 HANGERS

- A. Furnish and install all hangers of approved pattern and size to support all pipes in a substantial manner.
- B. See Section 220529 – HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT of these specifications for pipe hangers and brackets.
- C. Hangers for overhead piping shall comply with NBFU requirements as to size and spacing. Special and improvised supports and hangers shall meet with the approval of the Underwriters Laboratories and the Architect

PART 3 - EXECUTION

3.1 SERVICE-ENTRANCE PIPING

- A. Connect sprinkler piping to water-service piping for service entrance to building.

- B. Install shutoff valve, check valve, pressure gage, and drain and other accessories indicated at connection to water service.

3.2 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 - 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.
 - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
 - 3. It shall be the responsibility of the contractor to examine the building and the drawings, confirming all dimensions before any pipe is cut, to determine if any offsets, etc., are necessary. Where additional offsets are required, they shall be made without any additional cost to the architect.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.
- 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 and smaller.
- E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 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. Fill wet-pipe sprinkler system with water.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- M. 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 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal and install where they are not subject to freezing.
- N. Be responsible for locating all openings required in walls, floors, ceilings or roof, for all materials and equipment furnished under this section of the specifications.
- O. Sleeves or openings shall be provided for passage of pipes. Where openings or sleeves have been omitted, they shall be drilled or sawed as required by the architect. All cutting and patching shall be done by the trades whose work is affected. All expenses incurred shall be a responsibility of this section of the specifications.

- P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 SLEEVING, CUTTING, PATCHING AND REPAIRING – PLUMBING.
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 SLEEVING, CUTTING, PATCHING AND REPAIRING – PLUMBING.
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220517 SLEEVING, CUTTING, PATCHING AND REPAIRING – PLUMBING.

3.3 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 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 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. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.
- I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- J. 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.
- K. 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.
- L. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- M. 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.
- N. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 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. Install valves in vertical position for proper direction of flow, in main supply to system.
 - 2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.

3.5 SPRINKLER INSTALLATION

- A. All heads must "line up" and work in with the ceiling pattern of the lights and heating equipment. All heads located in lay-in ceiling tile shall be centered along the centerline of the tile. Heads may be located at the center and quarter points of the tile. Avoid ducts, lights, hangers, etc. 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. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.6 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13. Piping shall be marked on 20' centers. Where pipe extends through walls, identify pipe on both sides of wall.
- B. Identify system components, wiring, cabling, and terminals.

3.7 FIELD QUALITY CONTROL

- A. Perform the following 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 according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Verify that equipment hose threads are same as local fire department equipment.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.8 CLEANING

- A. Clean dirt and debris from sprinklers.

- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.9 EXTERIOR FIRE PROTECTION WATER PIPING

- A. Installation is subject to final approval of the Fire Marshall and local water company.
- B. Mains shall be buried with a minimum of 3.5 ft. of coverage per FM. Mains shall be flushed with water at a minimum of 6 ft. per second, and hydrostatically tested at 200 psi for 2 hours. The contractor shall provide a material and test certificate to the engineer to verify proper testing.
- C. Provide all concrete work required for thrust blocks, etc. See drawings for thrust block requirements.
- D. Provide all excavation and backfill required. See Section 220200 – EXCAVATION AND BACKFILLING FOR UNDERGROUND PIPING.

END OF SECTION 21 10 00

SECTION 22 01 00 – GENERAL PROVISIONS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. This section covers the general arrangement of the plumbing systems and related items to complete the work as shown on the drawings and as specified herein.
- B. The General and Special Conditions and all other Contract Documents are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- C. The Contractor shall familiarize himself with the work of all other trades, general type construction and the relationship of his work to other sections. He shall examine all working drawings, specifications and conditions affecting his work. The Contractor shall visit the premises and thoroughly familiarize himself with all details of the work and working conditions, verify all dimensions in the field and advise the Engineer of any discrepancy before performing any work.
- D. The work shall include complete testing of all equipment and piping at the completion of the work and making any minor connection changes or adjustments necessary for the proper functioning of the system and equipment.
- E. The Contractor shall perform all necessary temporary work during construction.
- F. Work under this section shall conform to all governing codes, ordinances and regulations of the City, County and State.
- G. The Contractor shall be responsible for all errors in fabrication, for the correct fitting, installation and erection of the various plumbing systems as shown on the drawings.

1.2 SCOPE

- A. This branch of the work includes coordination with all utility companies; providing utility meters; utility tap on fees; agency review fees and all inspection fees; all labor, materials, tools, excavation and backfill and all equipment necessary for the installation of Plumbing Systems as shown on the Drawings and Specifications and/or as required for complete and operating systems. The work shall include starting, balancing and the necessary and required tests to insure the proper operation of the complete system.
- B. A complete and operating plumbing system shall be provided. See plans for diagrams and details.
- C. All work for this project must comply and be in strict accordance with the Kentucky Building Code, Kentucky Plumbing Code, Kentucky Boiler Code, NFPA, ADA, NEC and all local codes and regulations.
- D. In general (as a minimum) all materials and equipment must be installed in strict accordance with manufacturer's requirements; and provided with all required controls, internal fusing, relays, piping connections, electrical connections, etc., to provide for complete and operable systems.
- E. All equipment shall be manufactured within 24 months of bid date, no exceptions. Any equipment installed outside of this timeframe shall be removed and replaced to meet this requirement at no additional cost to the owner.

1.3 PERMITS, FEES, CODES AND APPROVALS

- A. Permits and Fees
 - 1. All permits, tap on fees and agency review and inspection fees necessary for the complete Fire Protection and Plumbing systems shall be obtained by the

Contractor from the authorities governing such work. The cost of all permits shall be borne by the Contractor.

B. Codes

1. The minimum standard for all plumbing work shall be the requirements of the Kentucky State Plumbing Law, Regulation and Code, Kentucky Building Code, ADA, The Division of Water Quality, and local ordinances. All plumbing and fire protection for this project must as a minimum comply and be in strict accordance with the Kentucky Building Code, Kentucky Plumbing Code, Kentucky Boiler Code, NFPA, ADA, NEC, The Division of Water Quality and the "Standards of Safety" of the Commonwealth of Kentucky.
2. All drinking water system components that convey or dispense water for human consumption through drinking or cooking shall be NSF/ANSI 61 and/or NSF/ANSI 372 certified or listed as 'lead free' and meet any and all state and local requirements.

C. Approvals

1. All work must be approved by the Architect/Engineer, Owner and all related Code Agencies before final payment will be made.
2. As a minimum, the following approval Certificates of Inspection and Approval shall be required:
 - a. Plumbing Inspection
 - b. Health Department Inspection
 - c. Electrical Inspection
 - d. Local and State Building Inspections.
3. Final payment will be contingent upon all Approval Certificates.

1.4 DRAWINGS AND SPECIFICATIONS

- A. Contract drawings for work under this section are in part diagrammatic, intended to convey the scope of work and indicate the general arrangement of equipment, piping and the approximate size and location of equipment and outlets. The Contractor shall follow these drawings in laying out his work and shall verify spaces in which his work will be installed, indicating to the Engineer where any conflicts or overlapping of systems occur. Any item of work not clearly included, specified and/or shown, errors or conflict between Plans (Plumbing, Mechanical, Architectural, Structural or Electrical), Specifications, codes and field conditions, shall be clarified by a written request to the Architect by the Bidder before bidding; otherwise, the bidder shall, at his own expense, supply the proper labor and materials to include these items of work and to make good any damages or defects in his work caused by such error, omission or conflict. Under no circumstances shall a Contractor scale the Drawings for the location of equipment and work.
- B. Where job conditions require reasonable changes in indicated locations and arrangement, proposed departures shall be submitted with detailed drawings to the Engineer for approval before any of the proposed work is commenced. All approved departures shall be made at no additional cost to the Owner.
- C. The drawings and the specifications are intended to indicate complete and working systems, unless specifically indicated to the contrary. The work includes the furnishing, installing, and connecting of a complete working installation in each case to the full extent set forth in the drawings and herein specified. The Contractor shall be responsible for the complete functioning system, unless specifically noted otherwise.
- D. The drawings and specifications constitute the Contract Documents and shall be considered as cooperative. Work and material included in either, though not mentioned in

both, shall be a part of the work to be accomplished and shall be carried out completely in as thorough manner as if covered by both. All items shown on the drawings and/or listed in the specifications shall be provided and installed by the Contractor unless specifically noted that it will be provided and/or installed by others. In the event there is a conflict within the Contract Documents, the Contractor shall notify the Engineer immediately. If a clarification is not given, the Contractor shall bid the more stringent of the two requirements.

- E. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings and accessories that may be required. The Contractor shall carefully investigate the structural and finish conditions affecting all his work and shall arrange such work, accordingly, furnishing such fittings, pipe, traps, valves, and accessories as may be required to make a functional installation at no additional cost to the Owner.
- F. Plumbing as built "Record Drawings" shall be kept up to date each day. "Record Drawings" shall be reviewed by Architect/Engineer each month with contractor's pay request review.
- G. Any deviation in work as shown on plans and specifications must be approved in writing by Architect/Engineer prior to installation.

1.5 EXAMINATION OF SITE

- A. Bidders shall visit the site before submitting proposals to satisfy themselves as to the nature and scope of the work and any difficulties attending to the execution.
- B. The submission of a proposal will be construed as evidence that such an examination has been made. Later claims for labor, equipment, materials, etc., required for difficulties encountered which could have been foreseen had such an examination been made, will not be recognized.

1.6 EQUIPMENT DESIGN AND INSTALLATION

- A. The design, manufacture, testing and method of installation of all apparatus and materials furnished under the requirements of these specifications shall conform to the applicable standard rules of the following. Where materials are not specifically referred to, but are required, they shall meet the requirements of the applicable code.

- 1. NEMA -National Electrical Manufacturer's Assoc.
- 2. UL -Underwriter's Laboratories, Inc.
- 3. ASME -American Society of Mechanical Engineers
- 4. ASTM -American Society of Testing Materials
- 5. ASHRAE -American Society of Heating, Refrigerating and Air Conditioning Engineers
- 6. BOCA -Building Officials & Code Administrators International, Inc.
- 7. NFPA -National Fire Protection Association
- 8. AWWA -American Water Works Association
- 9. AWS -American Welding Society
- 10. AMCA -Air Moving and Conditioning Assoc.
- 11. ANSI -American National Standards Institute
- 12. NEC -National Electrical Code
- 13. AIEE -American Institute of Electrical Eng.
- 14. ARI -Air Conditioning & Refrigeration Institute

- 15. SMACNA -Sheet Metal and Air Conditioning Contractors National Assoc.
- 16. LSDHBC -Local and/or State Division of Housing, Building and Construction
- 17. SPC -State Plumbing Code
- 18. NPC -National Plumbing Code
- 19. OSHA -Occupational Safety and Health Adm.
- 20. EPA -Environmental Protection Agency
- 21. DOE -U.S. Department of Energy
- 22. IMC -International Mechanical Code
- 23. IECC -International Energy Conservation Code

- B. Unless otherwise specified, equipment and materials of the same type and used for the same purpose, shall be products of the same manufacturer.

1.7 CAPACITIES, SIZES AND OPERATING CONDITIONS

- A. Capacities, sizes, and conditions specified or shown on drawings shall be regarded as minimum allowable. If the Contractor proposes to furnish any equipment which would have to operate at other than specified conditions to produce final effects, all other directly or indirectly related components of the entire systems (as well as of the structure, finish and other systems in the building) must be properly coordinated to the satisfaction of the Engineer. That is: Operating conditions through the entire system must be such that no motor is overloaded, no equipment operates noisier, faster, or hotter than manufacturer's publication recommends and that no excess stress or demand is imposed on any component of any system or the structure; also that no quality, architectural feature, function or "end result" is affected adversely, in the opinion of the Architect.
- B. The Architect/Engineer reserves the right to determine if the contractor's proposed materials and equipment of any one manufacturer is acceptable in lieu of the specified material or equipment.
- C. Where materials and equipment are listed on Drawings and specifications as acceptable or equivalent, this does not relieve the contractor and/or manufacturer from providing and proving to Architect/Engineer that their materials and equipment are equivalent to items the Architect/Engineer used as a guide specification.
- D. The contractor and manufacturer must confirm to the Architect/Engineer that their equipment and materials will meet the space requirements of the project and that the equipment is easily accessible for maintenance and operation.
- E. In the event there is a conflict within the Contract Documents, the Contractor shall notify the Engineer immediately. If a clarification is not given, the Contractor shall bid the more stringent of the two requirements.

1.8 LAYOUT

- A. The Contractor's work lines, and established heights shall be in strict accordance with drawings and specifications insofar as these drawings and specifications extend. The Contractor shall verify all dimensions shown and establish all elevations and detail dimensions not shown. He shall also correlate the time so that the work will proceed to the best advantage of the complete job as a unit. The Contractor shall be responsible for furnishing in ample time, any information required to revise footing elevations, build all chases and openings in floors, walls, partitions, ceilings, and roofs to provide clearance which may be required to accommodate the work. The contractor shall set all sleeves, anchor bolts and inserts required to accommodate his equipment before masonry is constructed.

- B. The Contractor shall layout his work well enough in advance to foresee any conflicts or interferences with work of other sections so that in case of interference, his layout may be altered to suit the conditions, prior to the installation of any work. This procedure will require constant coordination with all sections of the work.

1.9 DEMOLITION AND SCHEDULE

- A. All existing plumbing equipment noted on drawings and listed herein that is to be removed or demolished, shall be removed on schedule and disposed of as hereinafter directed.
- B. All items removed shall become the property of the contractor and shall be immediately disposed of offsite at contractor's expense except as noted on drawings unless otherwise directed by owner.
- C. All demolition shall be carefully accomplished in accordance with master construction schedule so as not to remove any item required for support operation during the planned schedule. No item shall be removed until full schedule is worked out with contractors according to owners demands and agreed to in writing by the Engineer.
- D. Storage will be arranged during scheduling process. Contractors to provide own storage and security.
- E. Contractor doing the demolition of equipment must conform to the Clean Air Act of 1990. Refrigerant must be recovered from any air conditioning or refrigeration equipment prior to disconnecting and disposal. The contractor must own and use recovery equipment to meet this requirement. The contractor will be responsible for disposal of refrigerant, refrigerant oil, or equipment.
- F. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damage or unserviceable portion and replace with new products of equal capacity and quality. All existing piping to remain shall be permanently capped, new or existing valves are not adequate.

1.10 ACCESSIBILITY

- A. All equipment, valves, motors, traps, unions, and all other items which require adjustment, maintenance, repair, and observation shall be installed in such a fashion that such maintenance, repair, and observation can be readily achieved without undue difficulty. Where the drawings show these items in locations not conforming to the above, the Contractor shall advise the Architect/Engineer of this conflict prior to bid Date otherwise he shall, at his own expense, relocate such items as directed by the Architect/Engineer. Where such items are installed above inaccessible ceilings or in or behind walls, this contractor shall provide approved access panels unless otherwise directed in these Specifications.

1.11 ARCHITECTURAL DRAWINGS AND SPECIFICATIONS

- A. Each Contractor shall refer to the Architectural and Civil Drawings and Specifications for the general construction of the building, for floor and ceiling heights, for location of walls, partitions, beams etc., and shall be guided accordingly for the setting of all sleeves and equipment.
- B. Under no circumstances shall a Contractor scale the Drawings for the locations of equipment and work.

1.12 STRUCTURAL DRAWINGS AND SPECIFICATIONS

- A. Each Contractor shall refer to the Structural Drawings and Specifications for the general construction of the building, for floor and ceiling heights, for location of walls, partitions, beams, grade beams, foundations, footings etc., and shall be guided accordingly for the setting of all sleeves and equipment.

- B. Under no circumstances shall a Contractor scale the Drawings for the locations of equipment and work.
- C. The contractor is responsible for reviewing all below slab / underground piping with structural components and coordinating all stepped footings or sleeves where required.

1.13 COOPERATION WITH OTHER CONTRACTORS

- A. Each Contractor shall demand and examine all Drawings and Specifications pertaining to the construction before installing the work described and shown under these Drawings and Specifications. Each Contractor shall cooperate with all other contractors in locating piping, openings, chases, and equipment in order to avoid conflict with any other contractor's work. It is the responsibility of all trades to examine all shop drawings of other trades that would require equipment to occupy the same space and plane within the building to eliminate any potential conflicts. No extra payment will be allowed for relocation of piping, and equipment not installed in accordance with the above instructions, and which interferes with work and equipment of other contractors.

1.14 INSTALLATION OF EQUIPMENT

- A. All appliances, materials and equipment shall be installed and connected in accordance with the best engineering practice and in accordance with manufacturer's instructions and recommendations. All auxiliary piping, special controls, water seals, valves, electrical connections, drains, etc., recommended by the manufacturer, required for proper operation, or required by code shall be furnished and installed complete.
- B. All equipment designed and constructed for indoor use shall not be shipped to the site until such time that the equipment is ready for permanent installation in a dry building or may be stored on site provided equipment is stored in a water and moisture tight storage building or job trailer. Covering equipment outdoors with plastic or tarp is not acceptable.

1.15 PROTECTION

- A. No piping shall be installed in any part of the building where danger of freezing may exist without adequate protection being given, whether insulation is specified for the particular piping. All damage resulting from leaking pipes shall be borne by the Contractor under this Division.
- B. All work, equipment and materials shall be protected at all times. All pipe openings shall be closed with caps or plugs during construction. All equipment and accessories shall be tightly covered and protected against dirt, water, or other injury during the period of construction.

1.16 CUTTING AND PATCHING

- A. All cutting and patching required in connection with the installation of this work, and work due to errors, defective work, ill-timed work or tardiness in properly designating size and location in sufficient time or by failure to notify other trades, shall be done under this section, but only in the manner directed by the Engineer so as to prevent or minimize damage to installed work. Damage as a result of cutting for installation, shall be repaired by mechanics skilled in the trade involved, at no additional expense to the Owner.
- B. No cutting of structural members will be permitted, except when prior permission of the Engineer has been obtained. This work must conform in every respect to the surrounding finish and to the quality of workmanship and materials used.
- C. Piercing of any waterproofing or roofing shall be done only by the trade involved. After the part piercing the waterproofing has been set in place, the opening made for this purpose shall be filled and made absolutely watertight to the satisfaction of the Engineer.
- D. See Section: 220517 - SLEEVING, CUTTING, PATCHING AND REPAIRING

1.17 FIRE AND SMOKE-STOPPING

- A. Fire-stopping and smoke-stopping shall be provided around all piping penetrations of fire rated and/or smoke-rated floors, walls, ceilings, or other barriers.
- B. The materials used shall be UL 263 or UL 1479 classified and meet ASTM E814 standards and be rated for assemblies where applied.
- C. Clean surfaces to be in contact with penetration seal materials, of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.
- D. Install penetration seal materials in accordance with manufacturer's instruction.
- E. Seal holes or voids may be penetrations to ensure an effective fire and/or smoke barrier.
- F. Protect materials from damage on surfaces subject to traffic.
- G. Stop insulation flush with wall on insulated pipe and seal edges.
- H. All exposed piping passing through floors, ceilings and walls in finished areas shall be fitted with a chrome plated escutcheon of sufficient outside diameter to amply cover the sleeved opening and ad inside diameter to closely fit the pipe around which it is installed.

1.18 CONCRETE WORK AND ANCHOR BOLTS

- A. The Contractor under this Division shall provide all concrete bases, curbs and pads for all floor and ground mounted equipment unless otherwise indicated.
- B. The Contractor under this Division shall verify the sizes and locations of all supports, bases, and pads prior to pouring of same to be certain that the installed units will be compatible.
- C. The Contractor under this Division shall set anchor bolts when required for the equipment prior to pouring of concrete. Sizes and exact locations of bolts shall be determined by the manufacturer's recommendations for the equipment served.
- D. Concrete work must be provided in strict accordance with Section 03 Concrete Work. As a minimum provide pads using 3500 psi concrete not less than 3.5 inches high reinforced with W1.4 x W1.4 welded wire fabric. Chamfer top and edge corners with 3/4" preformed chamfer strips. Subbases shall rest on structural floor and shall be reinforced with steel rods and interconnected with floor reinforcing bars by tie bars hooked at both ends or suitable dowels. Slope top to floor drain if drain is provided in pad.

1.19 ACCESS PANELS

- A. The Plumbing Contractor shall furnish all other access panels needed for access to valves, open receptacles, etc., in inaccessible locations installed under this Division of the work.
- B. Access panels shall have a minimum size of 12" x 12" and shall be centered beneath equipment for accessibility and maintenance. Access panels must be of adequate size to service, observe, remove, and maintain equipment.
- C. Access panels shall be equal to the types specified under the Architectural Specifications. As a minimum the access panels shall be equivalent to Acudor Products, Cendrex, Inc., MIFAB, Inc., Lane-Aire Manufacturing, 14 gauge with vandal proof lock and frame as selected by Architect. Access panels shall be fire rated when installed in fire rated construction.
- D. Access panels shall have a primed white finish.
- E. Ceiling Types

1. In areas with suspended acoustical tile ceilings (installed on exposed metal grid suspension system so that the tile may be readily removed), equipment, valves, etc., install above these ceilings will be accessible.
 2. All plastered ceilings or ceilings having concealed spline type of suspension system will be considered as not removable for accessibility to equipment; therefore, access panels will be required.
 3. See Architectural Drawings and Specifications for the types of ceilings throughout the building.
- F. Access panels shall be installed by sub-contractor specialized in access panel installation.

1.20 CONNECTION TO EQUIPMENT SPECIFIED IN OTHER SECTIONS

- A. Examine all Contract Documents and be thoroughly familiar with all items of equipment in other sections or by Owner, unless otherwise specified or indicated on Drawings. Rough-in for and make final connections to all equipment which requires any of the services specified in this Section and including furnishing and install all valves, P-traps, unions, vacuum breakers and all other specialties as required to make all work and equipment final and operating. It is the intent of the Contract Drawings to detail and indicate all such equipment; however, be responsible for notifying Architect/Engineer in writing of major discrepancies seven (7) days prior to Bid Date; otherwise, all such connections shall be made at no extra cost.
- B. Unless specified otherwise, all conduit, wiring and connections for power to plumbing equipment will be provided by Electrical Contractor. Be responsible for correct sequences of operation of all plumbing equipment after all wiring has been completed.

1.21 OPERATING INSTRUCTIONS

- A. After all tests have been completed and work accepted by the Owner, a competent representative shall, at a time determined by the Engineer, present verbal, and visual instructions to the Owner's personnel in the proper operation of his respective system. For this purpose, each section of work shall be demonstrated and explained to the Owner's personnel and sufficient time allotted for instructions. See Specification Section 220600.

1.22 SAFETY

- A. The contractor and his subcontractors for the project shall comply with all applicable Federal, State, and local laws governing safeguards, safety devices, and protective equipment and shall take all other needed actions which they may determine or which the Department may determine to be reasonably necessary to protect the life and health of all employees and personnel on the project, provide for the safety of the public and protect all property affected by the performance of the work covered by the contract.
- B. As provided in KRS Chapter 338 in the Kentucky Occupational Safety and Health Act and in subsequent regulations and standards promulgated by the Kentucky Occupational Safety and Health Standards Board, neither the Contractor nor his subcontractors shall require any laborer or mechanic employed in performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health and safety.
- C. The contractor shall not remove or disturb any suspected hazardous materials, including asbestos-containing materials, lead based paints, electrical equipment containing PCB's, or any other except as instructed in this contract. If any material not covered by the contract is encountered, notify the Engineer immediately.

1.23 TESTS - GENERAL

- A. All tests required to establish the adequacy, quality, safety, completed status and suitable operation of each system and all components thereof shall be made in the presence of and to the satisfaction of the Engineer or his authorized representative and other representatives of State and local Government. All instruments, labor, and expert service necessary to conduct these tests shall be supplied by the Contractor; power and fuel will be furnished by the Owner.
- B. The final inspection and tests are to be made only after the Engineer is satisfied that the work described in these specifications has been completely installed in accordance with the true spirit and intent of these specifications and that complete preliminary tests were made which indicate adequacy, quality, completion and satisfactory operation. The acceptance of the work herein specified, shall not in any way prejudice the Owner's right to demand replacement of defective material and/or workmanship.

1.24 CLEANING

- A. General: Clean all piping and equipment systems as required to leave the piping and equipment clean and free from scale, silt, contamination, etc., as normally required and as specified herein.
- B. Utilities and Equipment: The Contractor shall provide all necessary temporary materials and equipment to clean the piping and equipment installed under this specification. No permanent equipment shall be used for storage, mixing, settling, compressing, pumping, etc., without the approval of the Architect. The Contractor shall supply a separate and independent source of clean, dry, oil-free air for the blowdown of systems requiring this method of cleaning.
- C. Use of Chemicals: No chemicals, wetting or drying agents shall be used to clean systems or equipment where the materials of the system undergo any changes in their physical or structural characteristics. In case of any doubt as to the compatibility of any materials to the cleaning solution used, the Contractor shall obtain prior written approval for the use of the solution from the manufacturer of the equipment. Piping systems, equipment and sub-assemblies shall be cleaned after completion of welding, machining, threading, testing and any other operations capable of contaminating the system piping or equipment. After cleaning, the permanent strainers shall be removed, cleaned, and replaced. Temporary strainers shall be periodically removed, cleaned, and replaced during cleaning in lines ahead of equipment to protect against particles becoming lodged in the equipment.
- D. After the Architect/Engineer has complete examination, this Contractor shall remove all stickers, tags, etc., and shall thoroughly clean all equipment, fixtures, and materials installed under his section of the work.
- E. Surplus material, rubbish and equipment resulting from the work shall be removed from the building and premises by the Contractor upon completion of the work in accordance with the General Conditions.
- F. All equipment shall be thoroughly cleaned to "Factory New" condition prior to turning over to owner. Touch up or completely repaint equipment as required.
- G. Keep all nameplates on equipment clean and exposed for easy reading.

1.25 WARRANTY AND SERVICE

- A. All equipment shall be warranted for a period of at least one (1) year from the date of acceptance, as evidenced by date of substantial completion for the entire project or for the last phase of the project, whichever occurs later, against defective materials, design, and workmanship. In addition to the equipment warranty, the Contractor shall provide all repair and adjustment service necessary for the proper operation of the entire system for a period of one (1) year after the date of acceptance, as evidenced by the date of

substantial completion for the entire project or for the last phase of the project, whichever occurs later. Upon receipt of notice from the Owner's representative of failure of any part of the warranted system or equipment during the warranty period, the affected part shall be replaced promptly with a new part without cost to the Owner. Upon failure to take action within 24 hours after being notified, the work will be accomplished by the Engineer at the expense of the Contractor. See General Conditions and individual equipment specifications. Note that the warranty period of time specified in this section represents the minimum warranty period required for work performed under specification Division 21, 22 and 23. Where the General Conditions and/or individual equipment/system specifications require a warranty period of longer duration or earlier start date than specified in this paragraph, the longer duration/earlier start date shall supersede for those portions of work covered by that specification. In the event the contractor is notified of warranty issues but does not correct or address the warranty issues prior to the end of the specified warranty period, the contractor will not be relieved of the responsibility to correct the deficient items after the warranty end date has passed.

- B. Make a minimum of two (2) service calls during guarantee period, free of charge, to check with Owner and to check and repair malfunctioning equipment which was installed. Service calls shall be in middle and end of guarantee period and as required to maintain systems operation. Dates shall be listed in operating and maintenance manuals, along with contractor's name and phone number.

1.26 ELECTRIC MOTORS

- A. All motors shall be designed, tested, and applied in accordance with the applicable standards listed hereinbefore. Motors shall be of sufficient size for the duty to be performed and shall not exceed the full load rating when the driven equipment is operating at specified capacity. Unless otherwise specified, all motors shall be high efficiency type and shall have open frames and continuous-duty classification based on 50 degrees C. ambient temperature. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics. Motors shall meet NEMA high efficiency standards MGI - 1.41.2 for energy efficient polyphase squirrel-cage motor. Efficiency shall be in accordance with MGI - 1.2.55. When motor horse powers required differ from those indicated on the drawings, the Contractor shall make the necessary adjustments to the wiring, disconnect devices, starters, and branch-circuit protection at no additional cost to the Owner.
 - 1. Motors shall be rated for continuous duty capable of driving the connected loads without exceeding temperature limitations of the motor insulation. Special Class A moisture-resisting insulation (designed to operate in a 50-degree C. ambient without exceeding a temperature rise rating designated by NEMA for the type of enclosure used) shall be utilized in each motor.
- B. Unless otherwise indicated or specified, the electrical components required to operate plumbing equipment, such as, motors, float and pressure switches, solenoid valves, and other devices functioning to control the plumbing equipment, shall be furnished as part of the plumbing equipment, shall be complete and operable, and shall be included under this section of the specifications. All motor starters not part of a motor control center shall be included under this Section and shall be the hand off auto type with 3 over-loads on 3 phase units and 120V control transformer. Conduit and wires required for external electrical connections shall be furnished and are specified under DIVISION 26 - ELECTRICAL. Integral phase failure relay shall be provided as a part of all three phase motor starters. Relay shall shut motor down on phase loss or phase unbalance and automatically reset when normal phasing is restored. Phase failure relay shall have adjustable restart time capabilities. Plumbing contractor shall coordinate staggered restart times as required.

1.27 AS-BUILT DRAWINGS

- A. The Contractor shall deliver to the Engineer at the completion of the work, one (1) print of "As-Built" drawings, showing legibly and accurately, plumbing and piping systems with equipment locations shown as actually installed. Changes in original plans shall be neatly shown in red pencil. Each print shall be signed by the sub-contractor who has done the work.
- B. During construction, the Contractor shall retain a set of blue line drawings on the site for recording all changes. These drawings shall be available for inspection by the Engineer.

1.28 TESTS

- A. The Architect/Engineer shall be notified by the Contractor under this Division forty-eight (48) hours in advance of any tests so that the Architect/Engineer or his representative may be present when the tests are run. Leaks or imperfections found shall be corrected and a new test shall be run to the satisfaction of the Architect/Engineer. Upon successful completion of the test, pipe covering may be applied, and piping may be concealed. A successful test, even if witnessed, however, does not relieve the Contractor under this Division of the responsibility for any failure during the guarantee period.
- B. After pipe fabrication has been completed, all water piping shall be subjected to a hydrostatic test of 100 psi and proven tight and free of leaks for a 24-hour period. Tests shall be applied to the piping before being attached to any equipment which would be damaged by the test pressure. Damage to equipment caused by testing shall be repaired or replaced without additional cost to the Owner.
- C. The sanitary sewer piping and sanitary waste, vent and drainage piping installed under this Division in, under or outside the building shall be tested by means of water, smoke or air in accordance with the Kentucky State Plumbing Law, Regulation and Code, Division of Water Quality and the local utility company requirements. These shall be made in the presence of the Plumbing Inspector and the Architect/Engineer.
- D. Exterior water piping shall be tested in strict compliance with local water company. The minimum hydrostatic test pressure is 1 1/2 times the water pressure serving the site.
- E. No insulation, paint, backfill or other prohibitive covering shall be applied to piping prior to the above tests.
- F. Provide all temporary equipment, materials, valves, gauges, etc., required for the preceding tests.
- G. The expense of all tests shall be borne by the Contractor under this Division.

1.29 CONTRACTOR FURNISHED DRAWINGS, DESCRIPTIVE DATA AND MANUALS

- A. Approval of Materials and Equipment: Within 30 days of receipt of notice to proceed, and before starting installation, the Contractor shall submit to the Architect for approval, in triplicate, lists of materials, fixtures and equipment to be incorporated in the work. If departures from the contract drawings are deemed necessary by the Contractor, details of such departures, including changes in related portions of the project and the reasons therefore shall be submitted with drawings. Where such departures require piping or equipment to be supported otherwise than shown, the details submitted shall include loadings and type and kinds of frames, brackets, stanchions, or other supports necessary. Approved departures shall be made at no additional cost to the Owner. The lists of materials and equipment shall be supported by sufficient descriptive material, such as catalog cuts, diagrams, and other data published by the manufacturer, as well as evidence of compliance with safety and performance standards, to demonstrate conformance to the specification requirements; catalog numbers alone will not be acceptable.

- B. Conformance to Agency Requirements: Where materials or equipment are specified to be constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers, the Air Moving and Conditioning Association, or the American Society of Heating, Refrigerating and Air Conditioning Engineers, or to be approved by the Underwriters' Laboratories, Inc., the Contractor shall submit proof that the items furnished under this specification conform to such requirements. A certificate or published statement by the manufacturer will be sufficient evidence that the item conforms to the specified requirements. In lieu of such stamp, certificate, or statement, the Contractor may submit written certificate from any nationally recognized testing agency adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the requirements listed hereinbefore, including methods of testing, of the specified agencies.
- C. Shop Drawings
1. In accordance with the General Conditions, shop drawings shall be submitted on all units of prefabricated materials. Shop drawings shall show, in detail, all parts of the work, fully dimensioned and shall also indicate construction, concealed and other jointing, thickness of materials, method of anchoring and attachment to other materials. Where required for certain work, submit setting and bending diagrams and mark same to correspond with the design drawings, identifying locations of various items. Show types, sizes and locations of sleeves and inserts.
 2. The Contractor shall check all shop drawings for completeness and for correctness before submitting the drawings. If major corrections are required on the drawings, the Contractor shall return the drawings to the originator and have the changes made. The Contractor shall indicate his corrections on the prints in green pencil and sign all prints and other material sent to the Engineer.
 3. Detail and Erection Drawings: Detail and erection drawings for equipment, piping and other items of this nature shall be carefully prepared in accord with standard practice and shall show erection plans and member details with all individual parts identified on both the detail sheets and erection plans. All identification markings shall be carefully preserved until after the erection process is completed.
 4. Material Data: The Contractor shall submit descriptive data, as required, on pipe, fittings, and valves to be incorporated into the work. This data shall be in sufficient detail to allow the Engineer to determine that the pipe, fittings, and valves meet the requirements of the contract drawings and specifications or that they are an acceptable equal to that specified. All data shall be in the form of manufacturer's or supplier's literature concerning the product and shall indicate catalog number, conditions of use, application instructions, and/or other information as applicable.
 5. Equipment Data: The Contractor shall submit descriptive data on all items of equipment to be furnished and installed under this contract. These submittals shall consist of manufacturer's published catalog information which completely describes component materials, configuration and rough-in data for plumbing and electrical equipment shall also include cuts, diagrams, characteristic curves, and capacity information as applicable. Where more than one item of equipment is employed in the same system, the submittal of equipment data will include special diagrams showing the electrical wiring, interconnecting piping, related controls and relation and operation of the various items of equipment for the entire system.

D. Operating Instructions and Maintenance Manuals, Etc.

1. At completion of the contract, the Owner shall be provided with three (3) bound copies of operations and maintenance instructions, recommended list of spare parts required for a period of one (1) year and a list of any special tools required to maintain the equipment for the various items of the plumbing equipment. Where special tools are required, the Contractor shall furnish two (2) of each such tools to the Owner at no additional contract cost.
2. MANUAL SHALL INCLUDE ALL APPROVED SHOP DRAWINGS OF EQUIPMENT REQUIRING OPERATION AND MAINTENANCE INFORMATION.
3. MANUAL SHALL BE ORGANIZED WITH APPROVED SHOP DRAWING FOLLOWED BY ALL RELATED OPERATION AND MAINTENANCE MATERIAL.
4. EQUIPMENT SHALL BE IDENTIFIED IN ACCORDANCE WITH THE DRAWING NOMENCLATURE AND INCLUDE SUPPLIER OF SAID EQUIPMENT.
5. Instructions shall be included for routine checking of all items requiring continued maintenance.
6. Schematic drawings with actual pieces of plumbing equipment, etc., shall be included; where manufacturer's parts numbers only are applicable, they shall be included.
7. Detailed operating instructions for plumbing equipment shall be included, as well as general maintenance procedures to be followed on such equipment. Manufacturers maintenance and operation manuals will be required where such are normally available with the equipment, but as such information is often of a general nature and applicable to various models of equipment, such information shall be supplemented by specified typed directions for the particular piece of equipment applicable to this project.

E. Materials, Equipment and Appliances

1. Materials: All materials, equipment, products and incidentals to be furnished by the Contractor shall be new, unless otherwise specified, undamaged and the first line quality product of the manufacturer and/or supplier, except when competitive grades fully meet the standards specified in the various technical sections of these specifications.
2. Standard Products: Except as otherwise approved by the Engineer, the equipment, and appliances to be furnished under these specifications shall be the standard products of manufacturers regularly engaged in the production of such equipment and shall be the manufacturer's latest standard design. Where two or more units of the same type and class of equipment are required, the units shall be the product of the same manufacturer and shall be identical insofar as possible. The component parts of the products need not be products of one manufacturer.
3. Manufacturer's Directions: Where manufacturer's instructions or recommendations are applicable to the installation or application of materials, the Contractor shall adhere to strict conformance with such instructions or recommendations unless specifically noted to the contrary in these specifications. Where such directions conflict with the drawings and specifications, the Contractor shall inform the Engineer of such conflict and request instructions.
4. Samples: The Contractor shall furnish, for approval, samples of materials, profiles, designs, finishes, etc., which are either required by the various sections of specifications or which the Engineer may request from time to time. Samples shall be clearly identified with adequate information for the Engineer's evaluation.

5. Materials and Equipment Delivered to Jobsite: All items of materials, equipment, supplies and miscellaneous items to be incorporated into the work shall be delivered to the jobsite with labels, tags, nameplates and/or containers which clearly indicate the manufacturer's item or catalog number or conformance with the applicable standards stipulated in the technical sections of the specifications. Any item which cannot be verified in the field shall not be included in the work until its identity can be established by the Engineer.

F. Equipment and Material Substitutions

1. Should the Contractor elect to use and install materials which have been approved for use other than specified, he shall be required to make any necessary changes, perform all work and furnish any additional materials and ancillary equipment required to make such substituted materials or equipment function or perform as that specified, at no cost to the Owner. This includes structural, electrical and/or other affected trades.

1.30 DEFINITIONS

- A. Plumbing Contractor: Any contractor whether bidding or working independently or under the supervision of a general contractor and/or construction manager and who installs any type of plumbing work.
- B. Plumbing Sub-Contractor: Any contractor contracted to or employed by the plumbing contractor for any work required by the mechanical contractor.
- C. Engineer: The consulting mechanical/electrical engineers either consulting to the owners, architects, other engineers, etc.
- D. A-E: Shall construe architect and/or engineer. In all situations that involve an architect, it shall construe architect, in all others, engineer.
- E. Furnish: Deliver to the site in good condition and turn over to contractor responsible for installation.
- F. Provide: Furnish and install in complete working order.
- G. Install: Install equipment furnished by others.
- H. Indicated: Shown on the drawings or addenda thereto.
- I. Contract Documents: All documents pertinent to the quality and quantity of work to be performed on the project. Includes but not limited to plans, specifications, instructions to bidders, general and special conditions, addenda, alternates, list of materials, list of sub-contractors, unit prices, shop drawings, field orders, change orders, cost breakdown, periodical payment requests, etc.

1.31 INTENT

- A. It is the intention of these specifications and all associated drawings to call for finished work, tested and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use".
- B. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

1.32 DIGITAL DATA AND FILE TRANSMISSION

- A. Sub-Contractors (SC) requiring digital files to prepare shop drawings and governmental agency submittals shall make their request through the Construction Manager (CM) or General Contractor (GC).

1. The CM/GC shall compile a list of requested drawings from the respective SC's and submit one comprehensive list to STW.
 2. STW will provide the CM/GC with a digital file transmission release form. The CM/GC may sign and return or have the requesting SC's sign and return to STW through the CM/GC.
 3. After receiving the signed release form, STW will provide one set of all requested digital files to the CM/GC to then distribute to the appropriate SC's.
 4. STW will provide AutoCAD/dwg files.
 - a. Revit/BIM models will not be provided to contractors. Projects completed using REVIT will be exported to AutoCAD prior to releasing.
- B. The project architect is the owner/author of the floor plans and reflected ceiling plans.
1. The architect must approve the release of these plans before STW can release our respective drawings.
 2. Requests for floor plans and/or reflected ceiling plans only shall be made directly to the architect.

END OF SECTION 22 01 00

SECTION 22 02 00 – EXCAVATION AND BACKFILLING FOR UNDERGROUND PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Excavating and backfilling trenches for utilities and pits for buried utility structures. a

1.2 FIELD CONDITIONS

- A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
- D. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

2.2 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored to comply with local practice or requirements of authorities having jurisdiction.
- B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored to comply with local practice or requirements of authorities having jurisdiction.
- C. See specification Section 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.3 EXCAVATION FOR STRUCTURES

- A. Excavation for Underground Tanks, Basins, and Mechanical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.4 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe unless otherwise indicated.
 - 1. Clearance: 12 inches each side of pipe.
- C. All trench excavation side walls greater than five (5) feet in depth shall be sloped, shored, sheeted, braced or otherwise supported by means of sufficient strength to protect workmen within them in accordance with the applicable rules and regulations established for construction by the Department of Labor, Occupational Safety and Health Administration (OSHA), and by local ordinances. Lateral travel distance to an exit ladder or steps shall not be greater than 25 feet in trenches 4 feet or deeper.
- D. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes. Remove projecting stones and sharp objects along trench subgrade.
 - 1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- E. Trenches in Tree- and Plant-Protection Zones:
 - 1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 - 2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3.5 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect/Engineer.
 - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect/Engineer.

3.6 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.7 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
- D. Trenches under Roadways: Provide 4-inch thick, concrete-base slab support for piping less than 30 inches below surface of roadways. After installing and testing, completely encase piping in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
- E. Initial Backfill: Place and compact initial backfill of subbase material or satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe.
 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping to avoid damage or displacement of piping. Coordinate backfilling with utilities testing.
- F. Final Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
- G. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.8 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698 or ASTM D 1557:
 1. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.9 PROTECTION

- A. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.10 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 22 02 00

SECTION 22 05 17 – SLEEVING, CUTTING, PATCHING AND REPAIRING FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes requirements for the Plumbing Contractor related to sleeving, cutting, patching, and repairing associated with plumbing work.

1.2 WORK INCLUDED

- A. Sleeves
- B. Sleeve Seals
- C. Grout
- D. Escutcheons
- E. Lintels

1.3 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISIONS FOR PLUMBING WORK

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 water stop 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. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness, round tube closed with longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Metraflex Company (The).
 - 3. 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 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, 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.

2.3 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, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 ESCUTCHEONS

- A. Escutcheons shall be Beaton and Caldwell; Carpenter and Patterson; Fee and Mason or approved equivalent. Chromium-plated iron or chromium-plated brass, either one piece or split patterns, held in place by internal spring tension or set screw that completely covers opening.

2.5 LINTELS

- A. New openings under 48" in width: Provide one 3 1/2" x 3 1/2" x 3 1/2" steel angle for each 4" of masonry width. Lintel shall have 8" bearing on either side.
- B. New openings 48" to 96" in width: Provide one 3 1/2" x 6" x 3/8" steel angle for each 4" of masonry width. Lintel shall have 8" bearing on either side.
- C. New openings over 96" in width: Consult the project structural engineer.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall be responsible for all openings, sleeves, trenches, etc., that he may require or create by demolition in floors, roofs, ceilings, walls, etc., and shall coordinate all such work with the General Contractor and all other trades. Coordinate with the General Contractor, any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the Contractor.
- B. The Contractor shall plan his work ahead and shall place sleeves, frames or forms through the walls, floors, and ceilings during the initial construction, where it is necessary for piping, ductwork, conduit, etc., to go throughout; however, when this is not done, the Contractor shall do all cutting and patching required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Engineer. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at his own expense.
- C. The Contractor shall notify other trades in due time where he will require openings or chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.
- D. The Contractor shall be responsible for properly shoring, bracing, supporting, etc., any existing and/or new construction to guard against cracking, settling, collapsing, displacing, or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements shall be promptly and properly made good to the satisfaction of the Engineer.

- E. All work improperly done or not done at all as required by the Mechanical Trades in this section, will be performed by the Contractor at the direction of the trade whose work is affected.

3.2 SLEEVES

- 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 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 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.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- F. Pipes Passing Through Waterproofing Membranes: Pipes passing through floor waterproofing membrane shall be installed through a 4-pound lead-flashing sleeve, or a 0.032-inch thick aluminum sleeve, each with an integral skirt or flange. Flashing sleeve shall be suitably formed, and the skirt or flange shall extend not less than 8 inches from the pipe and shall set over the floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 1 inch above the floor. The annular space between the flashing sleeve and the metal-jacket-covered insulation shall be sealed. At the Contractor's option, pipes passing through floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and a pressure ring with brass bolts. Waterproofing membrane shall be clamped into space and sealant shall be placed in the caulking recess.
- G. Pipes Passing Through Roof: Pipes passing through the roof shall be installed where shown on the drawings. Any penetration in roof shall be approved by the Roofing Manufacturer.

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 ESCUTCHEONS

- A. Escutcheons shall be provided at all finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings. Escutcheons shall be fastened securely to pipe sleeves or to extensions of sleeves without any part of sleeves being visible. Where sleeves project slightly from floors, special deep-type escutcheons shall be used.

3.5 CUTTING

- A. All trades shall coordinate all openings in masonry walls with the General Contractor, and, unless otherwise indicated on the Architectural drawings, shall provide lintels for all openings required for the plumbing work (piping, wall boxes, etc.).
- B. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the engineer.
- C. Pipe openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.
- D. Openings in metal building walls shall be made in strict accord with building suppliers recommendations.

3.6 PATCHING AND REPAIRING

- A. Patching and repairing made necessary by work performed under this division shall be included as part of the work and shall be done by skilled mechanics of the trade or trades for work cut or damaged, in strict accordance with the provisions herein before specified for work of like type to match adjacent surfaces and in a manner acceptable to the engineer.
- B. Where portions of existing lawns, shrubs, paving, etc. are disturbed for installation or work of this Division, such items shall be repaired and/or replaced to the satisfaction of the engineer.
- C. Where the installation or removal of piping, etc. requires or creates the penetration of fire or smoked rated walls, ceilings or floors, the space around such pipe, etc., shall be tightly filled with an approved non-combustible fire insulating material satisfactory to maintain the rating integrity of the wall, floor or ceilings affected.
- D. Piping passing through floors, ceilings, and walls in finished areas, unless otherwise specified, shall be fitted with chrome plated brass escutcheons of sufficient outside diameter to amply cover the sleeved openings and an inside diameter to closely fit the pipe around which it is installed.
- E. Where pipes pass through exterior walls, the wall openings shall be sealed air and watertight. This shall include sealing on both sides of the wall to insure air and water does not enter or exit the wall cavity. This is especially critical on exterior walls where the wall cavity may be vented to the exterior.

END OF SECTION 22 05 17

SECTION 22 05 29 – HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Pipe and Equipment Hangers, Supports, and Associated Anchors

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISIONS FOR PLUMBING WORK
- C. Section 220719 - PLUMBING PIPING INSULATION
- D. Section 221000 - PLUMBING PIPING AND VALVES

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product.
 - 2. Show fabrication and installation details.

1.4 REFERENCES

- A. ANSI/ASME B31.1 - Power Piping

1.5 SCOPE

- A. This specification shall apply for the design and fabrication of all hangers, supports, anchors and guides. Where piping design is such that exceptions to this specification are necessary, the particular system shall be identified, and the exceptions approved by Engineer prior to installation. See drawings.

1.6 STRUCTURE

- A. This section is intended to cover the structural requirements of the piping and equipment. It is not intended to imply that the building structure will support the loads imposed. The contractor shall review the structural drawings for where loads can be applied, what load can be supported and what structural reinforcing is required. Specific questions can be directed to the structural engineer.

1.7 DESIGN

- A. All supports and parts shall conform to the latest requirements of the ANSI Code for Pressure Piping B31.1.0, and MSS Standard Practice SP-58, SP-69, and SP-89 except as supplemented or modified by the requirements of this specification.
- B. Designs generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized wherever possible.
- C. Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.
- D. Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent excessive stress resulting from transferred weight being induced into the pipe or connected equipment.
- E. Where possible, steel structural attachments shall be beam clamps. Other attachments shall be as scheduled.

- F. All rigid hangers shall provide a means of vertical adjustment after erection.
- G. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit swing.
- H. Where horizontal piping movements are greater than ½ inch, or where the hanger load angularity from the vertical is greater than 4 degrees from the cold to hot position of the pipe, the hanger rod to structural attachment shall be by use of Anvil Fig. 47 and Fig. 299 or the hanger rod and structural attachments shall be offset in such manner that the rod is vertical in the hot position.
- I. Contractor to fabricate and provide additional structural support as required to prevent sway where hanger rod lengths exceed 48" in length.
- J. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.
- K. All piping and equipment shall be braced and secured to prevent sway and movement in all axes.
- L. Hangers shall be spaced in accordance with ANSI B31.1.0
- M. Where practical, riser piping shall be supported independently of the connected horizontal piping.
 - 1. Pipe support attachments to the riser piping shall be riser clamp lugs. Welded attachments shall be of material comparable to that of the pipe and designed in accordance with ANSI B31.1 codes.
- N. Supports, guides and anchors shall be so designed that excessive heat will not be transmitted to the building steel. The temperature of support parts shall be based on a temperature gradient of 100 degrees F per inch distance from the outside surface of the pipe.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Anvil, B-Line, Elcen, Mason Industries, Advanced Thermal, Fee & Mason, Piping Specialties, MIRO Industries.

2.2 SHIELDS

- A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi 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 beyond sheet metal shield for piping operating below ambient air temperature.
- F. Shields for Copper Pipe shall utilize sheet lead.

2.3 INSERTS

- A. Inserts: Malleable iron case or galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 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: Pre-galvanized, hot dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder coated.
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. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel.

2.5 TRAPEZE PIPE HANGERS

- ### A.
- Description: MSS SP-58, 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.

2.6 METAL FRAMING SYSTEMS

A. 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 factory-fabricated components for field assembly.
3. Channels: Continuous slotted carbon-steel channel within turned lips.
4. Channel Width: Selected for applicable load criteria.
5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel.
7. Metallic Coating: Pre-galvanized G90 (Z275).

2.7 BEAM CLAMPS

1. Beam clamps shall have malleable iron jaws, steel bolt or tie rod, nuts, and jamb nuts.
2. C-clamps will not be permitted unless retainer is provided.

2.8 PIPE STANDS

- ### A.
- General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support above grade, floor, and roof (without roof penetration).
- ### B.
- Compact Pipe Stand:

1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe.
 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 3. Hardware: Galvanized steel or polycarbonate.
 4. Accessories: Protection pads.
- C. Low-Profile, Single Base, Single-Pipe Stand:
1. Description: Single base with vertical and horizontal members, and pipe support.
 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 3. Members: Two, galvanized-steel, continuous-thread 1/2-inch rods.
 4. Horizontal Member: Adjustable horizontal, galvanized-steel pipe support channels.
 5. Pipe Supports: Roller.
 6. Hardware: Galvanized steel.
 7. Accessories: Protection pads.
 8. Height: 12 inches above grade, floor, or roof.
- D. High-Profile, Single Base, Single-Pipe Stand:
1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 2. Base: Single vulcanized rubber or molded polypropylene.
 3. Vertical Members: Two, galvanized-steel, continuous-thread 1/2-inch rods.
 4. Horizontal Member: One, adjustable height, galvanized-steel pipe support slotted channel or plate.
 5. Pipe Supports: Roller.
 6. Hardware: Galvanized.
 7. Height: 36 inches above grade, floor, or roof.
- E. High-Profile, Multiple-Pipe Stand:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 2. Bases: Two or more; vulcanized rubber.
 3. Vertical Members: Two or more, galvanized-steel channels.
 4. Horizontal Members: One or more, adjustable height, galvanized-steel pipe support.
 5. Pipe Supports: Roller.
 6. Hardware: Galvanized steel.
- 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.

2.9 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.10 OUTDOOR EQUIPMENT STANDS

- A. Description: Individual foot supports with elevated adjustable channel cross bars and clamps/fasteners/bolts for ground or roof supported outdoor equipment components, without roof membrane penetration, in a prefabricated system that can be modularly assembled on site.
- B. Foot Material: Rubber or polypropylene.
- C. Rails Material: Hot dip galvanized carbon steel.
- D. Wind/Sliding Load Resistance: Up to 100 mph minimum.

2.11 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 INSERTS

- A. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- B. Where concrete slabs form finished ceiling, provide inserts to be flush with slab surface.

3.2 PIPE HANGERS AND SUPPORTS

- A. Comply with MSS SP-58 for pipe-hanger selections and applications.
- 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 framing systems and attachments for general service applications.
- E. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- F. Use thermal-hanger shield inserts for insulated piping and tubing.
- G. Install hangers to provide minimum ½ inch space between finished covering and adjacent work.
- H. Place a hanger within 12 inches of each horizontal elbow.
- I. Provide hangers with 1-1/2-inch minimum vertical adjustment.
- J. Provide additional structural support where required to prevent pipe movement and sway.
- K. Support riser piping independently of connected horizontal piping.
- L. Support piping as follows:

Nominal Pipe Size	Single Rod Diameter	Thickness of Insulation Shield	Maximum Spacing Ferrous Piping	Copper Tubing	HDPE Piping
3/4" & Under	3/8"	16 gauge	6'	5'	2.5'
1"	3/8"	16 gauge	7'	6'	3'
1 1/4"	3/8"	16 gauge	8'	8'	4'

1 ½"&2"	3/8"	16 gauge	9'	8'	4'
2 ½"&3"	½"	12 gauge	12'	8'	4'
4" & 5"	5/8"	12 gauge	14'	8'	4'
6"	¾"	10 gauge	14'	8'	4'
8"	7/8"	8 gauge	14'	10'	5'

END OF SECTION 22 05 29

SECTION 22 05 48 – VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 – GENERAL

1.1 SUMMARY

- A. This specification includes vibration isolation, equipment balancing requirements and sound level criteria for equipment spaces and exterior mounted equipment.
- B. Mechanical and electrical equipment and associated piping and ductwork shall be mounted on vibration isolators as specified and/or required to minimize transmission of vibration and structure-borne noise to building structure or spaces.
- C. It is the intent of the seismic portion of this specification to keep all mechanical and electrical building system components in place during a seismic event.
- D. All rotating equipment shall be balanced both statically and dynamically. The equipment when mounted and placed in operation shall not exceed a self-excited vibration velocity of 0.10 inches per second in the vertical, horizontal, or axial directions when measured with a vibration meter on the bearing caps or at the equipment mounting feet if the bearings are concealed.
- E. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Elastomeric isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Open-spring isolators.
 - 5. Housed-spring isolators.
 - 6. Restrained-spring isolators.
 - 7. Housed-restrained-spring isolators.
 - 8. Pipe-riser resilient support.
 - 9. Resilient pipe guides.
 - 10. Air-spring isolators.
 - 11. Restrained-air-spring isolators.
 - 12. Elastomeric hangers.
 - 13. Spring hangers.
 - 14. Snubbers.
 - 15. Restraints - rigid type.
 - 16. Restraints - cable type.
 - 17. Restraint accessories.
 - 18. Post-installed concrete anchors.
 - 19. Concrete inserts.
 - 20. Vibration isolation equipment bases.
 - 21. Restrained isolation roof-curb rails.
- F. Related Requirements:

1. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
2. Section 230100 - GENERAL PROVISIONS FOR MECHANICAL WORK

1.2 DEFINITIONS

- A. Designated Seismic System: A plumbing component that requires design in accordance with ASCE/SEI 7, Ch. 13, and for which the Component Importance Factor is greater than 1.0.
- B. All equipment or systems with a component importance factor of 1.0 [$I_p=1.0$] is referred to as "Life Safety" (stay in place) for equipment that must remain in place during an earthquake without regard to its ability to remain functional, it certifies that the anchoring system for isolated or non-isolated equipment will not fail, and the equipment will not fall onto building occupants or other essential equipment.
- C. All equipment or systems with a component importance factor of 1.5 [$I_p=1.5$] is referred to "Essential" (stay in place and remain operational) for equipment that not only meets the above conditions but must not fail internally or externally. This requires an independent dynamic seismic analysis of the equipment for a Certificate of Compliance and may require modification of the unit by the manufacturer or the system by the contractor. This factor also applies to components containing hazardous materials and to components in or attached to an Occupancy Category IV structure and its failure could impair the continued operation of the facility.
- D. IBC: International Building Code.

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 1. Product Data: For each type of product.
 2. Detail fabrication and assembly of equipment bases.
 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.
- B. Delegated Design Submittals:
 1. For each seismic-restraint device, including seismic-restrained mounting, pipe-riser resilient support, snubber, seismic restraint, seismic-restraint accessory, concrete anchor and insert, and restrained isolation roof-curb rail that is required by this Section or is indicated on Drawings, submit the following:
 - a. Seismic Restraint, and Vibration Isolation Base Selection: Select vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
 - b. 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 by professional engineer that riser system was examined for excessive stress and that none exists.
 - c. Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.

- d. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
 - e. Qualified Professional Engineer: All designated-design submittals for seismic- and wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
2. Seismic Restraint Detail Drawing:
- a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.
3. All delegated design submittals for seismic-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
4. Product Listing, Preapproval, and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and basis for approval (tests or calculations).
5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For professional engineer and testing agency.
- C. Welding certificates.
- D. Field quality-control reports.
- E. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-10 Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.
 - 1. Provide equipment manufacturer's written certification for each designated active mechanical seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction or experience data as permitted by ASCE/SEI 7-10.

2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-10.
3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.
4. The following plumbing systems and components are Designated Seismic Systems and require written special certification of seismic qualification by manufacturer:
 - a. Inline pumps, water heaters, expansion tanks, domestic water piping, gas piping, etc.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-spring isolators and restrained-air-spring isolators to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that require periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Mason Industries, Amber/Booth Company, Vibration Elimination Co., Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic load control system.
 1. Seismic Performance: Equipment to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7-10.
- B. Consequential Damage: Provide additional seismic restraints for suspended plumbing components or anchorage of floor-, roof-, or wall-mounted plumbing components as indicated in ASCE/SEI 7-10 so that failure of a non-essential or essential plumbing component will not cause failure of any other essential architectural, mechanical, or electrical building component.
- C. Fire/Smoke Resistance: Seismic restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723 and be so labeled.
- D. Component Supports:
 1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-10 Section 13.6.

2.3 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Source Limitations: Obtain elastomeric isolation pads from single manufacturer.
2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
5. Surface Pattern: Smooth, ribbed, or waffle pattern.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient and elastomeric.
 - a. Surface Pattern: Smooth, ribbed, or waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.4 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

1. Source Limitations: Obtain double-deflection, elastomeric isolation mounts from single manufacturer.
2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolt.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.5 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:

1. Source Limitations: Obtain restrained elastomeric isolation mounts from single manufacturer.
2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - a. Housing: Cast-ductile iron or welded steel.
 - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.6 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Source Limitations: Obtain freestanding, laterally stable, open-spring isolators from single manufacturer.

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 rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates limit floor load to 500 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.7 HOUSED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:
 1. Source Limitations: Obtain freestanding, laterally stable, open-spring isolators in two-part telescoping housing from single manufacturer.
 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 rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
 - b. Top housing with attachment and leveling bolt.

2.8 RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
 1. Source Limitations: Obtain restrained-spring isolators from single manufacturer.
 2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
 - b. Top plate with threaded mounting holes.
 - c. Internal leveling bolt that acts as blocking during installation.
 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 HOUSED-RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:
 - 1. Source Limitations: Obtain freestanding, open-spring isolators with vertical-limit stop restraints from single manufacturer.
 - 2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
 - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.10 PIPE-RISER RESILIENT SUPPORT

- A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch-Thick Neoprene:
 - 1. Source Limitations: Obtain all-directional, acoustical pipe anchor from single manufacturer.
 - 2. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 - 3. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.11 RESILIENT PIPE GUIDES

- A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch-Thick Neoprene:
 - 1. Source Limitations: Obtain resilient pipe guides from single manufacturer.
 - 2. Factory-Set Height Guide with Shear Pin: Shear pin to be removable and re-insertable to allow for selection of pipe movement. Guides to be capable of motion to meet location requirements.

2.12 AIR-SPRING ISOLATORS

- A. Freestanding, Single or Multiple, Compressed-Air Bellows:
 - 1. Source Limitations: Obtain air-spring isolators from single manufacturer.
 - 2. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
 - 3. Maximum Natural Frequency: 3 Hz.
 - 4. Operating Pressure Range: 25 to 100 psig.

5. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
6. Automatic leveling valve.

2.13 RESTRAINED-AIR-SPRING ISOLATORS

- A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint:
 1. Source Limitations: Obtain restrained-air-spring isolators from single manufacturer.
 2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
 - b. Top plate with threaded mounting holes.
 - c. Internal leveling bolt that acts as blocking during installation.
 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 7. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
 8. Maximum Natural Frequency: 3 Hz.
 9. Operating Pressure Range: 25 to 100 psig.
 10. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
 11. Automatic leveling valve.

2.14 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
 1. Source Limitations: Obtain elastomeric hangers from a single manufacturer.
 2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.15 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
 1. Source Limitations: Obtain spring hangers from single manufacturer.

2. 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.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.16 SNUBBERS

- A. Source Limitations: Obtain snubbers from single manufacturer.
- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-14 Ch. 17 for 2015 or 2018 IBC.
 2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
 3. Anchors in Masonry: Design in accordance with TMS 402.
 4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

2.17 RESTRAINTS - RIGID TYPE

- A. Source Limitations: Obtain rigid-type restraints from single manufacturer.
- B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.18 RESTRAINTS - CABLE TYPE

- A. Source Limitations: Obtain cable-type restraints from single manufacturer.
- B. Seismic-Restraint Cables: ASTM A1023/A1023M galvanized cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.
- C. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.19 RESTRAINT ACCESSORIES

- A. Source Limitations: Obtain restraint accessories from single manufacturer.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.20 POST-INSTALLED CONCRETE ANCHORS

- A. Mechanical Anchor Bolts:
 - 1. Source Limitations: Obtain mechanical anchor bolts from single manufacturer.
 - 2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.
- B. Adhesive Anchor Bolts:
 - 1. Source Limitations: Obtain adhesive anchor bolts from single manufacturer.
 - 2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
- C. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-10, Ch. 13.
 - 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
 - 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.
- D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 HP that is not vibration isolated.
 - 1. Undercut expansion anchors are permitted.

2.21 CONCRETE INSERTS

- A. Source Limitations: Obtain concrete inserts from single manufacturer.
- B. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.
- C. Comply with ANSI/MSS SP-58.

2.22 VIBRATION ISOLATION EQUIPMENT BASES

- A. Source Limitations: Obtain vibration isolation equipment bases from single manufacturer.

- B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails to have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases to have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- D. Concrete Inertia Base: Factory-fabricated or field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases to have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 - 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- 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 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.
- D. Flexible connections shall be provided for all connections indicated on drawings, manufactured of materials suitable for the operating temperatures and pressures of the fluid or gas it is conveying.
 - 1. Flexible hose shall be installed in accordance with the manufacturer's recommendations including placement in the pipeline without damage, misalignment or change in its normal length. Prior to filling the system, the alignment and length shall be checked by loosening the flange bolts to determine the installation conditions. The piping installation shall be corrected if necessary and the flexible hose replaced if damaged, at no cost to the Owner.

3.3 INSTALLATION OF VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICES

- A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Devices Schedules, where indicated on Drawings, or where Specifications indicate they are to be installed on specific equipment and systems.
- B. Provide seismic-restraint devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
- C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- D. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- E. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- F. Equipment Restraints:
 - 1. Install seismic snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- G. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
 - 4. Pipe Exclusions
 - a. Gas piping less than 1" inside diameter.
 - b. Piping in boiler and mechanical rooms less than 1 1/4" inside diameter.
 - c. All other piping less than 2 1/2" inside diameter.

- 1) All piping suspended by clevis hangers where the distance from the top of the pipe to the suspension point is 12" or less.
 - 2) All trapezed piping where the distance from the suspension point to the trapeze member is 12" or less.
 - 3) If any suspension location in the run exceeds the above, the entire run must be braced.
- H. Install seismic-restraint cables so they do not bend across edges of adjacent equipment or building structure.
- I. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- M. Mechanical Anchor Bolts:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 221000 "Plumbing Piping and Valves" and Section 221119 "Domestic Water Specialties" for piping flexible connections.

3.5 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

- A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

- B. Coordinate dimensions of steel equipment rails and bases, concrete inertia bases, and restrained isolation roof-curb rails with requirements of isolated equipment specified in this and other Sections. Where dimensions of these bases are indicated on Drawings, dimensions may require adjustment to accommodate actual isolated equipment.

3.6 ADJUSTING

- A. Adjust isolators after system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.7 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. Tests and Inspections:
 - 1. Perform tests and inspections with the assistance of a factory-authorized service representative.
 - 2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
 - 4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 5. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
 - 6. Test to 90 percent of rated proof load of device.
 - 7. Measure isolator restraint clearance.
 - 8. Measure isolator deflection.
 - 9. Verify snubber minimum clearances.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Units will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 22 05 48

SECTION 22 05 53 – IDENTIFICATION OF PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

- A. Identification of products installed under Division 21 and 22 including:
 - 1. Plastic Nameplates
 - 2. Plastic Tags
 - 3. Metal Tags
 - 4. Stencils and Paint
 - 5. Plastic Pipe Markers
 - 6. Plastic Tape Pipe Markers
 - 7. Underground Plastic Tape Pipe Markers

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISIONS FOR PLUMBING WORK

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product indicated.
 - 2. Piping and Equipment Label Schedule: Include a listing of all piping and equipment to be labeled with the proposed content for each label.
 - 3. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
 - 4. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Valve Schedules for each piping system to include in operation and maintenance manual.

1.5 REFERENCES

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Brady Corp., Craftmark Pipe Markers, Seton Identification Products.

2.2 Color: Unless specified otherwise, conform with ANSI/ASME A13.1.

2.3 Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.4 Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2-inch square.

2.5 Metal Tags: Brass or aluminum with stamped letters; tag size minimum 1-1/2-inch diameter with smooth edges.

2.6 Stencils: With clean cut symbols and letters of following size:

Outside Diameter of Insulation or Pipe	Length of Color Field	Size of Letters
3/4" - 1-1/4"	8"	1/2"
1-1/2" - 2"	8"	3/4"
2-1/2" - 6"	12"	1-1/4"
8" - 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

A. Stencil Paint: Semi-gloss enamel black unless otherwise indicated.

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

2.8 Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.9 Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape of not less than 6-inch-wide by 4 mil thick, manufactured for direct burial service.

A. Underground plastic piping to be installed with a tracer wire.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

A. Plastic Nameplates: Install with corrosive-resistant mechanical fasteners, or adhesive.

B. Plastic or Metal Tags: Install with corrosive-resistant chain.

C. Stencil Painting: Apply in accordance with manufacturer's instructions.

D. Plastic Pipe Markers: Install in accordance with manufacturer's instructions.

E. Plastic Tape Pipe Markers: Install complete around pipe in accordance with manufacturer's instructions.

F. Underground Plastic Pipe Markers: Install 6 to 8 inches below finished grade, directly above buried pipe.

G. Equipment: Identify plumbing equipment such as but not limited to pumps, water heaters, storage tanks, expansion tanks, water treatment devices etc. with plastic nameplates. Small devices, such as in-line pumps, may be identified with plastic or metal tags.

H. Controls: Identify control panels and major control components outside panels with plastic nameplates.

I. Valves: Identify valves in main and branch piping with tags.

- J. Piping: Identify piping, concealed, or exposed, with plastic pipe markers or plastic tape pipe markers. Stenciled painting may be used on insulation. Tags may be used on small diameter piping. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and "T", at each side of penetration of structure or enclosure, and at each obstruction.

3.3 VALVES AND CHARTS

- A. The Contractor under this Division shall attach a numbered brass tag to each valve installed under this Contract. Each number shall be prefixed with the "P" for plumbing valves. Tags shall be attached to the valves by means of brass "S" hooks. Tags shall be Seton Name Plate Co., C.H. Hanson Co. or Identifications.
- B. A chart headed "PLUMBING VALVE CHART" shall be prepared. Three original charts shall be prepared and approved by the engineer. One of each approved type of chart shall be framed under glass and mounted on the wall in the main mechanical room where directed. Three photocopies of each chart shall be made and shall be submitted through normal shop drawing channels for approval and subsequent owner's files. Each chart shall be formatted as shown below: (All normally closed valves shall have a brass tag marked Normally Closed.)

PLUMBING VALVE CHART

PROJECT NAME

DATE

TAG NO.	VALVE LOCATION	VALVE TYPE/SIZE	VALVE FUNCTION

END OF SECTION 22 05 53

SECTION 22 06 00 – PLUMBING SYSTEMS DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
 - 3. Demonstration and training DVDs.

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISIONS FOR PLUMBING WORK

1.3 SUBMITTALS

- A. Instruction Program: Submit copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module
 - 1. At completion of training, submit training manual for Owner's use which includes receipts signed by the Owner acknowledging that training took place.
- B. Attendance Record: For each training module, submit list of participants and length of instruction time.
- C. Demonstration and Training DVDs: Provide recording of all demonstrations and training given and submit DVD within ten days of end of each training module.
 - 1. Identification: Provide an applied label with the following:
 - a. Name of Project
 - b. Name of Engineer
 - c. Name of Contractor
 - d. Date DVD was recorded
 - e. Description of information recorded.
 - 2. Transcript: Prepared on 8-1/2-by 11-inch paper, punched and bound in heavy-duty, three ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding DVD. Include name of Project and date of DVD on each page.

1.4 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

- C. Coordinate content of training modules with operation and maintenance manual information.

PART 2 - PRODUCTS

2.1 DEMONSTRATION AND TRAINING PROGRAM

- A. Provide program that includes individual training modules for each system and equipment not a part of a system as required by individual Specification Sections and as follows, but not limited to:
 - 1. Plumbing: Provide demonstration and training by showing Owner personnel the major components of the plumbing system as follows:
 - a. Domestic water meter and location of meter
 - b. Domestic water entrance to building and all related components
 - c. Domestic hot water heaters and location of each
 - d. Domestic hot water circulating pumps and location of each
 - e. Domestic water mixing valves and location of each
 - f. Electronic flush valves and faucets
 - g. All plumbing fixture types
 - h. Overview of sanitary sewer system layout and major components such as cleanouts, manholes, grease trap, plaster trap, etc.
 - 2. Fire Protection: Provide demonstration and training by showing Owner personnel the major components of the fire protection sprinkler system as follows:
 - a. Building water entrance and all associated risers
 - b. Location of drain valves throughout the system
 - c. Location of spare sprinkler heads
 - d. Location of fire department connection
 - e. Location of fire protection vault

PART 3 - EXECUTION

3.1 PREPARATION

- A. Assemble materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual.

3.2 INSTRUCTION

- A. Engage qualified instructors to instruct Owner personnel to adjust, operate, and maintain systems, subsystems, and equipment not a part of a system.
- B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
- C. Schedule training with Owner, through Architect/Engineer, with at least ten days' advance notice.

3.3 DEMONSTRATION AND TRAINING DVDS

- A. Engage a qualified individual to record demonstration and training DVDs. Record each training module separately. Include classroom instructions and demonstrations.
- B. DVD Format: Provide high-quality DVD in full-size cassettes.

- C. Narration: Describe scenes on DVD as DVD is recorded. Include description of items being viewed.
- D. Transcript: Provide typewritten transcript of the narration.

END OF SECTION 22 06 00

SECTION 22 07 19 – PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Piping Insulation
- B. Jackets and Accessories

1.2 RELATED WORK

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISIONS FOR PLUMBING WORK
- C. Section 220553 - IDENTIFICATION OF PLUMBING PIPING AND EQUIPMENT

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.4 QUALITY ASSURANCE

- A. Materials: Flame spread smoke developed rating of 25/50 in accordance with ASTM E84.
- B. All pipe insulation shall be installed by mechanics specializing in this type of work. The finished product shall present a neat and workmanlike appearance. Insulation shall not be applied until all tests except operating tests have been completed, all foreign material, such as rust, scale, or dirt, has been removed and the surfaces are clean and dry. Insulation shall be clean and dry when installed and during the application of any finish.
- C. The insulation, insulating materials and related items shall be delivered to the jobsite in the manufacturer's unopened containers. The containers shall have labels stating the manufacturer's name, contents, quantity, and other pertinent data.

PART 2- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Insulations having the thermal and physical properties of the specific materials specified hereinafter, of any of the following manufacturers, or approved equal, are acceptable.

Armstrong

Knauf

Johns Mansville

Certain Teed/Saint Gobain

Owens Corning

Pittsburgh Corning

Rubatex

- B. The Engineer reserves the right to determine if the proposed insulating materials of any one manufacturer are acceptable in lieu of the specific insulation selected for the following applications.

2.2 INSULATION

- A. Type A glass fiber insulation; ANSI/ASTM C547; 'k' value of 0.23 minimum at 75 degrees F; noncombustible.
- B. Type B cellular foam; flexible, plastic; 'k' value of 0.25 minimum at 75 degrees F; ASTM C534. APArmaflex W (white) or APArmaflex SS (black) or equal.
- C. Type C vinyl plastisol prefabricated assemblies with 1/8 minimum wall thickness. Trap wrap protective kit by Brocar, Plumberex, Truebro or approved equal.

2.3 JACKETS

- A. Vapor Barrier Jackets: Kraft reinforced foil vapor barrier with self-sealing adhesive joints.
- B. PVC Jackets: One piece, premolded type.
- C. Canvas Jackets: UL listed treated cotton fabric, 6 oz/sq. yd.

2.4 ACCESSORIES

- A. Insulation Bands: 3/4-inch-wide; 0.015-inch-thick galvanized steel, stainless steel. 0.007-inch 0.18 thick aluminum.
- B. Metal Jacket Bands: 3/8-inch-wide; 0.015-inch-thick aluminum. 0.010-inch-thick stainless steel.
- C. Insulating Cement: ANSI/ASTM C195; hydraulic setting mineral wool.
- D. Finishing Cement: ASTM C449.
- E. Fibrous Glass Cloth: Unthreaded; 9 oz/sq. yd weight.
- F. Adhesives: Compatible with insulation.
- G. Treated wooden blocks.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install materials after piping has been tested and approved.

3.2 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Continue insulation with vapor barrier through penetrations, except on fire rated walls.
- C. In exposed piping, locate insulation and cover seams in least visible locations.
- D. On insulated piping with vapor barrier, insulate fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- E. Provide an insert, not less than 6 inches long, of same thickness and contour as adjoining insulation, between support shield and piping, but under the finish jacket, on piping 2 inches diameter or larger, to prevent insulation from sagging at support points. Inserts shall be cork or other heavy density insulating material suitable for the planned temperature range. Factory fabricated inserts may be used. Insert shall extend around bottom 120 degrees of pipe barrel and shall be included inside vapor barrier jacket where applied. See Section 220529 for shields and hangers.
- F. Neatly finish insulation at supports, protrusions, and interruptions.
- G. Jackets
 - 1. Indoor, Concealed Applications: Insulated pipes shall have standard jackets, with vapor barrier, factory-applied or field-applied. Insulate fittings, joints, and valves

with insulation of like material and thickness as adjoining pipe, and finish with glass cloth and adhesive. PVC jackets may be used.

2. Indoor, Exposed Applications: For pipe exposed in mechanical equipment rooms or in finished spaces, insulate as for concealed applications. Finish with canvas jacket; size for finish painting. Do not use PVC jackets.
3. Flanges, Valves, Anchors and Fittings: Unless otherwise specified, all flanges, valves, anchors, and fittings shall be insulated with factory pre-molded or field fabricated segments of insulation of the same materials and thickness as the adjoining pipe insulation. When segments of insulation are used, elbows shall be provided with not less than three segments. For other fittings and valves, segments shall be cut to required curvatures, or nesting size sectional insulation shall be used. The segments of the insulation shall be properly placed and jointed with fire-resistant adhesive. After the insulation segments are firmly in place, fire-resistant vapor barrier coating shall be applied over the insulation in two coats with glass tape embedded between coats. The coating shall be applied to a total dry film thickness of 1/16 inch minimum. All glass tape seams shall be terminated neatly at the ends of the unions with insulating cement troweled on the bevel. For piping operating below ambient temperature, the beveled ends shall receive a coat of vapor barrier coating. Where anchors are used and secured directly to low temperature piping, they shall be insulated for a distance to prevent condensation, but not less than 6 inches from the surface of the pipe insulation. For jacket facing to receive finish painting, the factory applied jacket shall be as specified herein, except that the kraft paper shall be light colored with the kraft paper exposed. Field applied vapor barrier jacket shall conform to the above conditions where finish painting is required.

Piping	Type	Pipe Size (inch)	Thickness (inch)
Domestic Hot Water Supply/Recirculation	A/B	all	1
Domestic Cold-Water	A/B	all	1
Copper Water Piping Below Slab and Inside Walls	B	all	½
Chrome Plated Piping to Handicapped Lavatories	C	all	½
Chrome Plated Piping to Plumbing Fixtures		None	
Storm Water Piping	A	all	1

END OF SECTION 22 07 19

SECTION 22 10 00 – PLUMBING PIPING AND VALVES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Pipe and Pipe Fittings
- B. Valves
- C. Sanitary Sewer Piping
- D. Domestic Water Piping
- E. Gas Piping

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 – GENERAL PROVISIONS FOR PLUMBING WORK
- C. Section 220200 – EXCAVATION AND BACKFILLING FOR UNDERGROUND PIPING
- D. Section 220553 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT
- E. Section 220719 – PLUMBING PIPING INSULATION
- F. Section 221119 – DOMESTIC WATER PLUMBING SPECIALTIES
- G. Section 221319 – SANITARY AND STORM PIPING SPECIALTIES
- H. Section 224200 – PLUMBING FIXTURES AND EQUIPMENT

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product.

1.4 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Welding Materials and Procedures: Conform to ASME Code.
- C. Welders Certification: In accordance with ANSI/ASME Section 9.
- D. Cast Iron Pipe: All cast iron pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and shall be listed by NSF International.
- E. Hubless Cast Iron Couplings: All couplings for hubless cast iron soil pipe and fittings shall conform to CISPI 310, be certified by NSF International, or ASTM C1540 Heavy Duty.
- F. All drinking water system components that convey or dispense water for human consumption through drinking or cooking shall be "lead-free" in accordance with NSF/ANSI 61 and/or NSF/ANSI 372 standards and any and all state and local requirements.

1.5 COORDINATION WITH STRUCTURAL DRAWINGS AND SPECIFICATIONS

- A. Each Contractor shall refer to the Structural Drawings and Specifications for the general construction of the building, for floor and ceiling heights, for location of walls, partitions,

beams, grade beams, foundations, footings etc., and shall be guided accordingly for the setting of all sleeves and equipment.

- B. Under no circumstances shall a Contractor scale the Drawings for the locations of equipment and work.
- C. The contractor is responsible for reviewing all below slab / underground piping with structural components and coordinating all stepped footings or sleeves where required.

PART 2 - PRODUCTS

2.1 SANITARY SEWER PIPING BURIED INSIDE AND OUTSIDE OF BUILDING

- A. PVC Pipe and Fittings (Inside Building):
 - 1. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
 - 2. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
 - 3. Adhesive Primer: ASTM F 656.
 - 4. Solvent Cement: ASTM D 2564
- B. PVC Pipe and Fittings (Outside Building):
 - 1. PVC Type PSM Sewer Piping:
 - a. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
 - b. Fittings: ASTM D 3034, PVC with bell ends.
 - c. Gaskets: ASTM F 477, elastomeric seals.
 - 2. Provide tracer wire for all buried non-metallic piping.

2.2 SANITARY WASTE AND VENT PIPING, INTERIOR, ABOVE GRADE

- A. PVC Pipe and Fittings (shall not be used within air plenums)
 - 1. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
 - 2. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
 - 3. Adhesive Primer: ASTM F 656.
 - 4. Solvent Cement: ASTM D 2564.

2.3 WATER PIPING, EXTERIOR, UNDERGROUND

- A. PVC, AWWA Pipe: AWWA C900, Class 150, with bell end with gasket, and with spigot end. NPS 4 and NPS 6.
 - 1. Comply with UL 1285 for fire-service mains if indicated.
 - 2. PVC Fabricated Fittings: AWWA C900, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - 3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - 4. Provide tracer wire for all nonmetallic piping.
- B. Copper Tubing: ASTM B88, Type K. Fittings: ANSI/ASME B1629, wrought copper. Joints: ANSI/ASTM B52, solder, Grade 95TA.

- C. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 for not less than 150 psig pressure rating. Fittings: ANSI/ASTM D2466, PVC. Joints: ASTM D2855, solvent weld or ASTM F477 elastomeric seals.

- 1. Provide tracer wire for all nonmetallic piping.

2.4 WATER PIPING, INTERIOR

A. Copper Piping

- 1. Aboveground. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper; cast or wrought copper, solder-joint fittings; and brazed or soldered joints.
- 2. Below slab. 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; wrought-copper, solder-joint fittings; and brazed joints.
- 3. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- 4. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- 5. Piping Joining Materials
 - a. Solder Filler Metals: ASTM B 32, lead-free alloys.
 - b. Flux: ASTM B 813, water flushable.
 - c. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.5 NATURAL GAS PIPING, EXTERIOR UNDERGROUND

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

- 1. Malleable-Iron threaded Fittings: ASME B16.3, Class 150, standard pattern.
- 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
- 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
- 4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

2.6 NATURAL GAS PIPING, EXTERIOR ABOVEGROUND

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

- 1. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
- 2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

2.7 NATURAL GAS PIPING, INTERIOR UNDERGROUND

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

- 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
- 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.

3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Piping below slab shall be run in conduit vented to the outside

2.8 NATURAL GAS PIPING, INTERIOR ABOVEGROUND

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

2.9 DIELECTRIC FITTINGS

- A. Dielectric Unions: ASSE 1079 Standard; 125 psig minimum pressure rating at 180 deg F; solder-joint copper alloy and threaded ferrous end connections.
- B. Dielectric Nipples: IAPMO PS 66 Standard: electroplated steel nipple complying with ASTM F 1545; 300 psig pressure rating at 225 deg F; male threaded or grooved end connections; inert and noncorrosive, propylene lining.

2.10 ESCUTCHEONS

- A. Escutcheons shall be Beaton and Caldwell; Carpenter and Patterson; Fee and Mason or approved equivalent. Chromium-plated iron or chromium-plated brass, either one piece or split patterns, held in place by internal spring tension or set screw that completely covers opening.

2.11 GATE VALVES

- A. Class 125, RS, Bronze Gate Valves (up to 2 inches):
 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. Crane, NIBCO, Stockham, Watts.
 2. Description:
 - a. Standard: MSS SP-80, Type 2. CWP Rating: 150 psig. Body Material: Bronze with integral seat and screw-in bonnet. Ends: Threaded and soldered joint. Stem: Bronze. Disc: Solid wedge; bronze. Packing: Asbestos free. Handwheel: Malleable iron, bronze, or aluminum.
- B. Class 125, OS&Y, Iron Gate Valves (over 2 inches):
 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. Crane, NIBCO, Stockham, Watts.
 2. Description:
 - a. Standard: MSS SP-70, Type I. CWP Rating: 150 psig. Body Material: Gray iron with bolted bonnet. Ends: Flanged. Trim: Bronze. Disc: Solid wedge. Packing and Gasket: Asbestos free.

2.12 BALL VALVES

A. Two-Piece, Bronze Ball Valves (up to 2 inches):

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. Crane, NIBCO, Milwaukee, Stockham, Watts.
2. Description:
 - a. Standard: MSS SP-110. CWP Rating: 150 psig. Body Design: Two piece. Body Material: Bronze. Ends: Threaded and soldered. Seats: PTFE. Stem: Stainless steel. Ball: Stainless steel. Port: Full.

2.13 BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:

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. Crane, NIBCO, Stockham, Watts.
2. Description:
 - a. Standard: MSS SP-67, Type I. CWP Rating: 150 psig. Body Design: Lug type; suitable for bi-directional dead-end service at rated pressure without use of downstream flange. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron. Seat: EPDM. Stem: One-or-two piece stainless steel. Disc: Aluminum bronze.

2.14 SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc (up to 2 inches):

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. Crane, NIBCO, Stockham, Watts.
2. Description:
 - a. Standard: MSS SP-80, Type 3. CWP Rating: 150 psig. Body Design: Horizontal flow. Body Material: ASTM B 62, bronze. Ends: Threaded or soldered. Disc: Bronze.

B. Class 125, Iron Swing Check Valves with Metal Seats (over 2 inches):

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. Crane, NIBCO, Stockham, Watts.
2. Description:
 - a. Standard: MSS SP-71, Type I. CWP Rating: 150 psig. Body Design: Clear or full waterway. Body Material: ASTM A 126, gray iron with bolted bonnet. Ends: Flanged or threaded. Trim: Bronze. Gasket: Asbestos free.

2.15 SPRING LOADED CHECK VALVES

A. Class 125, Lift Check Valves with Nonmetallic Disc:

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. Crane, NIBCO, Stockham, Watts.
2. Description:
 - a. Standard: MSS SP-80, Type 2. CWP Rating: 150 psig. Body Design: Vertical flow. Body Material: ASTM B 61 or ASTM B 62, bronze. Ends: Threaded or soldered. Disc: NBR, PTFE.

2.16 RELIEF VALVES

- A. Bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.
- B. Manufactured by Apollo, Consolidated, Kunkel, Watts and Zurn.

2.17 MANUAL GAS SHUT-OFF VALVES

A. Two-Piece, Full Port, Bronze Ball Valve with Bronze Trim: MSS SP-110 (up to 2 inches).

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. A.Y. McDonald Mfg., Brasscraft, Conbraco, Perfection Corp.
2. Description
 - a. Body: Bronze, complying with ASTM B 584. Ball: Chrome-plated brass. Stem: Bronze; blowout proof. Seats: Reinforced TFE; blowout proof. Packing: Threaded-body packnut design with adjustable-stem packing. Ends: Threaded, flared, or socket. CWP Rating: 600 psig. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

B. Cast-Iron, Non-Lubricated Plug Valves: MSS SP-78 (over 2 inches).

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. A.Y. McDonald Mfg., Mueller Co., Xomox Corp.
2. Description
 - a. Body: Cast iron, complying with ASTM A 126, Class B. Plug: Bronze or nickel-plated cast iron. Seat: Coated with thermoplastic. Stem Seat: Compatible with natural gas. Ends: Threaded or flanged. Pressure Class: 125 psig. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

C. Bronze Plug Valves: MSS SP-78.

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. A.Y. McDonald Mfg., Lee Brass Company
 - b. Description
2. Body: Bronze, complying with ASTM B 584. Plug: Bronze. Ends: Threaded or socket. Pressure Class: 125 psig. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.18 MOTORIZED GAS VALVES

- A. Electrically Operated Valves: Comply with UL 429.
- B. 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. Asco, Fisher, Griswold, Watts.
- C. Description
 1. Pilot operated. Body: Brass or aluminum. Seats and Disc: Nitrile rubber.
 2. Springs and Valve Trim: Stainless steel. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable. NEMA ICS 6, Type 4, coil enclosure. Normally closed. Visual position indicator. Sized for service required.

2.19 GAS PRESSURE REGULATORS

- A. General Requirements
 1. Single stage and suitable for natural gas.
 2. Steel jacket and corrosion-resistant components.
 3. Elevation compensator.
 4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller.
- B. Line Pressure Regulators: Comply with ANSI Z21.80. Regulator may include vent limiting device instead of vent connection, if approved by Authority(ies) Having Jurisdiction (AHJ).
 1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
 2. Springs: Zinc-plated steel; interchangeable.
 3. Diaphragm Plate: Zinc-plated steel.
 4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
 5. Orifice: Aluminum; interchangeable.
 6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
 8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
 9. Overpressure Protection Device: Factory mounted on pressure regulator.
 10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

- C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
 - 1. Body and Diaphragm Case: Die-cast aluminum.
 - 2. Springs: Zinc-plated steel; interchangeable.
 - 3. Diaphragm Plate: Zinc-plated steel.
 - 4. Seat Disc: Nitrile rubber.
 - 5. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
 - 6. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
 - 7. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

2.20 SOLENOID VALVES

- 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. Asco, Fisher, Griswold.
- B. Description:
 - 1. Action: Either normally open or normally closed in the event of electrical power failure as required by the application. Size to close against the system pressure. Manual override capable. Heavy-duty assembly. Body: Brass. Seats and Discs: NBR or PTFE. Solenoid Enclosure: NEMA 250, Type 4.

2.21 GAUGE COCKS

- A. Ashcroft No. 1092; 150 PSIG maximum working pressure; bronze; 1/4" screwed connections; tee handle.
- B. All pressure gauges shall be installed with a gauge cock.

2.22 STRAINERS

- A. Strainers shall be Y type equal to Leslie, Illinois, or Mueller. Sizes 2 1/2" and larger shall be flanged; sizes 2" and smaller shall be screwed.
- B. Water strainers shall be cast iron or brass, designed for 125 lb. steam/200 lbs. WOG working pressure.
- C. Strainers shall have a free area of strainer screen a minimum of twice the area of the adjoining pipe. Strainer baskets shall be fabricated from stainless steel or Monel sheet metal; baskets shall have 0.045" (3/64") perforations for water service.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Pipe shall be cut accurately to measurements established at the jobsite and worked into place without springing or forcing, properly clearing all windows, doors, and other openings.

- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient.
- D. Install piping to conserve building space and not interfere with use of space. Do not change the designed path of piping, add excessive turns or offsets, or change pipe sizes without first consulting the Engineer.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide clearance for installation of insulation and access to valves and fittings.
- H. Provide access where valves and fittings are not exposed.
- I. Slope water piping and arrange to drain at low points.
- J. Establish elevations of buried piping outside the building to ensure not less than 3 feet of cover.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- L. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting.
- M. Establish invert elevations, slopes for drainage to be 1/8 inch per foot one percent minimum. Maintain gradients.
- N. Install bell and spigot pipe with bell end upstream.
- O. Install valves with stems upright or horizontal, not inverted.
- P. Escutcheons shall be provided at all finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings. Escutcheons shall be fastened securely to pipe sleeves or to extensions of sleeves without any part of sleeves being visible. Where sleeves project slightly from floors, special deep-type escutcheons shall be used.

3.3 EXCAVATION AND BACKFILL

- A. See specification SECTION 220200 EXCAVATION AND BACKFILLING FOR UNDERGROUND PIPING.
- B. As part of the work under these sections, provide all excavating and backfilling, including dewatering and shoring required for the introduction and completion of the work. The work performed under this heading must conform to surrounding grounds or finished grade and must be approved by the Engineer.
- C. All excavation shall be classified in accordance with the General Conditions of these specifications.
- D. Surplus material and materials unsuitable for use as fill or backfill of foundation or trench excavations shall be disposed of off the Owner's property at the Contractor's expense.
- E. Borrow material, if required, may not be available on Owner's property and shall be the responsibility of the Contractor to import any required material at his expense.
- F. Explosives and blasting shall not be permitted except by written permission of the Engineer.
- G. Where adjacent surface areas are disturbed as a result of construction operations or the storage of materials, they shall be cleaned of all debris and restored to original conditions.

- H. The Contractor shall be responsible for location in the field the excavation lines shown on the drawings. The location shall be approved by the Engineer before excavation is begun. The Contractor shall use reference points as shown on the drawings for locating control points for earthwork and construction. In the absence of reference points, the Contractor shall locate control points in accordance with the Engineer's instructions.
- I. Active utilities shown on the drawings shall be adequately protected from damage and removed or relocated only as indicated or specified. Where active utilities are encountered but are not shown on the drawings, the Engineer shall be advised; the work shall be adequately protected, supported, or relocated as directed by the Architect. Inactive and abandoned utilities encountered in excavating and grading operations shall be reported to the Architect; they shall be removed, plugged, or capped as directed by the Architect.
- J. Trench Excavation: The bottom of the trenches shall be accurately graded to provide uniform bearing and support for the pipe or concrete trench as shown on the drawings. Pipe shall be supported at every point along its entire length. Unless otherwise indicated, excavation shall be by open cut and trench sides shall be vertical. The trench bottom shall follow a uniform grade as shown on the drawings in the direction of flow insofar as possible. Where the trench has been excavated below grade, either inadvertently or purposely, the trench shall be backfilled and thoroughly tamped so as to provide full length bearing for the pipe barrel.
- K. Laying Pipe: Laying of pipe on blocks, brick, or wood to bring the pipe to a uniform invert shall not be permitted. Drainage lines shall be laid conform to the drawings. All pipe joints shall be inspected and approved prior to backfilling.
- L. Provide and install tracer wire for all buried non-metallic piping.

3.4 APPLICATION

- A. Use grooved mechanical couplings and fasteners only in accessible locations.
- B. Install unions downstream of valves and at equipment or apparatus connections.
- C. Install brass male adapters each side of valves in copper pipe system. Sweat solder adapters to pipe.
- D. Install ball and/or butterfly valves for shut-off and isolation of equipment, parts of systems, vertical risers and branch piping serving fixtures without a means of shut-off. Valves to be located in such a manner to be accessible for service personnel. Provide access panel(s) if required to access valves.
- E. Install ball valves for throttling, bypass, or manual flow control services.
- F. Provide spring loaded check valves on discharge of water pumps.
- G. Do not install above grade piping in areas subject to freezing. Where such an area is encountered, notify the engineer for instruction.

3.5 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed, and clean.
- B. Ensure PH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form, throughout system to obtain 50 to 80 mg/L residual.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.

- F. If final disinfectant residual test less than 25 mg/L, repeat treatment.
- G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- H. Take samples no sooner than 24 hours after flushing, from outlets and from water entry, and analyze in accordance with AWWA C601.

3.6 PAINTING OF GAS PIPING

- A. Comply with the requirements in painting specification sections for painting interior and exterior natural gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars and piping specialties, except components with factory-applied paint or protective coating.
 - 1. Alkyd System:
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior enamel.
 - d. Color: By Owner.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars and piping specialties, except components with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System:
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex.
 - d. Color: By Owner.
 - 2. Alkyd System:
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior alkyd enamel matching topcoat.
 - c. Topcoat: Interior alkyd.
 - d. Color: By Owner.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.7 SERVICE CONNECTIONS

- A. Provide new sanitary sewer service. Before commencing work check invert elevations required for sewer connections, confirm inverts, and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.
- B. Provide new water service complete with reduced pressure backflow preventer.

END OF SECTION 22 10 00

SECTION 22 11 19 – DOMESTIC WATER PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Backflow Preventers
- B. Water Hammer Arrestors
- C. Hose Bibbs/Hydrants
- D. Thermometers
- E. Pressure Gauges
- F. Trap Primers
- G. Water Pressure-Reducing Valves
- H. Balancing Valves
- I. Temperature-Actuated, Water Mixing Valves
- J. Sight Flow Indicators

1.2 RELATED WORK

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISIONS FOR PLUMBING WORK
- C. Section 221000 - PLUMBING PIPING AND VALVES
- D. Section 224200 - PLUMBING FIXTURES AND EQUIPMENT

1.3 REFERENCES

- A. ANSI/ASSE 1012 - Backflow Preventers with Immediate Atmospheric Vent
- B. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers
- C. ANSI/ASSE 1013 - Backflow Preventers, Reduced Pressure Principle
- D. ANSI/ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types
- E. ANSI A112.26.1 - Water Hammer Arresters
- F. PDI WH-201 Water Hammer Arresters

1.4 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product.

1.5 CLOSEOUT SUBMITTALS

- A. Approved Shop Drawings: For each type of product and related components requiring maintenance. Provide in operation and maintenance manual.
- B. Operation and Maintenance Data: Provide in operation and maintenance manual the following when provided:
 - 1. Backflow Preventers.
 - 2. Hose Bibbs/Hydrants

3. Trap Primers
4. Water Pressure-Reducing Valves
5. Temperature-Actuated, Water Mixing Valves

1.6 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.
- B. All drinking water system components that convey or dispense water for human consumption through drinking or cooking shall be NSF/ANSI 61 and/or NSF/ANSI 372 certified or listed as 'lead free' and meet any and all state and local requirements.

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

- A. Reduced Pressure Backflow Preventers: ANSI/ASSE 1013; bronze body with bronze and plastic internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve which opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.
- B. Double Check Valve Assemblies: ANSI/ASSE 1012; Bronze body with corrosion resistant internal parts and stainless-steel springs; two independently operating check valves with intermediate atmospheric vent.
- C. Manufactured by Ames, Apollo, Febco, Watts and Zurn.

2.2 WATER HAMMER ARRESTORS

- A. ANSI A112.26.1; sized in accordance with PDI WH-201, precharged suitable for operation in temperature range -100 to 300 degrees F and maximum 250 psig working pressure.

2.3 HOSE BIBBS

- A. ASME A112.18.1 for sediment faucets. Body Material: Bronze. Seat: Bronze, replaceable. Threaded or solder-joint inlet connection. Vacuum breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASME 1011. Chrome plated where exposed.

2.4 WALL HYDRANTS (NON-FREEZE)

- A. ASME A112.21.3M for concealed or exposed outlet, self-draining wall hydrant. Threaded or solder-joint inlet connection. Vacuum breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASME B1.20.7. Removable key operation.

2.5 THERMOMETERS

- A. Weiss No. 9VS type vari-angle 9" mercury filled heavy duty type: Marshalltown, Ashcroft, Marsh, or equivalent, Accuracy within 2% of scale span. Brass 3 1/2" (min.) stem complete with separable socker. Stem and socket must be of adequate length to give accurate temperature readings. Install in piping system in strict accordance with manufacturer's requirements. Increase pipe sizing at thermometer as required. Range 30 to 240 degrees F. for hot water piping, and 0 120 degrees F, for heat pump loop water, unless other standard range selected upon submittal. Contractor shall adjust case for readability from floor line.

2.6 PRESSURE GAUGES

- A. Weiss Series UG 1, Ashcroft, Marsh, Marshalltown or equivalent. 4 1/2" dial, range selected upon submittal; with maximum pointer; brass bourdon tube and socket; 1% accuracy.
- B. All pressure gauges shall be installed with lever handle gauge cock and brass straight coil siphon tube.

2.7 DRAINAGE TYPE TRAP-SEAL PRIMER

- A. Trap primer shall be listed and certified to ASME 1044, lavatory P-trap with braided 3/8" stainless steel flexible priming make-up water line with 5/8" compression fittings.
- B. Manufactured by Sioux Chief, PPP, Inc., and Zurn.

2.8 FLOW SENSING TRAP-SEAL PRIMER

- A. Trap primer shall be listed and certified to ASME 1018, constructed of 360 brass with EPDM E70 O-rings and stainless-steel screen.
- B. Trap primer shall automatically maintain a constant water seal based on pressure drop across the valve with no adjustments required.
- C. Provide with universal distribution unit as specified.

2.9 PRESSURE SENSING TRAP-SEAL PRIMER SYSTEMS

- A. Trap primer shall be listed and certified to ASME 1018 with lead-free body and cap, nitrile O-rings and stainless-steel screen.
- B. Trap primer shall be equipped with vacuum breaker ports and internal backflow protection to prevent cross connection.
- C. Provide with universal distribution unit as specified.

2.10 ELECTRONIC TRAP-SEAL PRIMER SYSTEMS

- A. Trap primer shall be listed and certified to ASSE 1044 and equipped with solenoid actuating device, ASSE 1001 vacuum breaker, distribution manifold and proper electronic hardware.
- B. Trap primer shall be equipped with an ASSE 1010 arrester to protect the solenoid valve.
- C. Recessed or surface mounted cabinet to be provided as specified.

2.11 WATER PRESSURE-REDUCING VALVES

- A. Water Regulators
 - 1. Standard: ASSE 1003, 150 psig.
 - 2. Body: Bronze with threaded end connections for NPS 2 and smaller; cast iron with flanged end connections with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
 - 3. Manufactured by Apollo, Conbraco, Watts and Zurn.
- B. Water-Control Valves
 - 1. Pilot operated, diaphragm-type, single-seated main water-control valve with initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings and sensor piping.
 - 2. Cast or ductile iron body with AWWA C550 or FDA-approved, interior epoxy coating. Threaded end connections for NPS 2 and smaller; flanged end connections for NPS 2-1/2 and larger.

3. Manufactured by Apollo, Conbraco, Watts and Zurn.

2.12 BALANCING VALVES

- A. Balancing valves shall be of the Lead Free, bi-direction, blow-out resistant, tight shutoff, ball design, with position indicator, memory device, checked metering ports with drip caps and integral drain ports opposite the metering ports. Provide a minimum of 24" of straight run of piping on each side of balancing valve assembly.
- B. Manufactured by Armstrong, Nibco or Watts.

2.13 TEMPERATURE-ACTUATED, WATER MIXING VALVES

- A. Valve shall be listed to ASSE 1017 and certified to CSA B125 and have an approach temperature of 5 degrees F. Valve shall have an outlet temperature range of 90 – 160 degrees F with a lockable temperature setting feature.
- B. Body shall be constructed using Lead Free brass material and be corrosive resistant and feature a single-seat design for positive shut-off. Valve shall have standard union check stops.

2.14 SIGHT FLOW INDICATORS

- A. Description: Piping inline-installation device for visual verification of flow. Minimum pressure rating: 125 psig. Minimum temperature rating: 200 deg F.
- B. Construction: Brass, bronze, or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
- C. Manufactured by Dwyer, Ernst Flow Industries, Flows.com, Kobold.

2.15 INSTALLATION

- A. General: Install plumbing specialty components, connections, and devices according to manufacturer's written instructions.
- B. Install backflow preventers of type, size, and capacity indicated, at each water-supply connection to mechanical equipment and systems, and to other equipment and water systems as indicated. Comply with authorities having jurisdiction. Locate backflow preventers in same room as connected equipment. Install air-gap fitting on units with atmospheric-vent connection and pipe relief outlet drain to nearest floor drain. Do not install bypass around backflow preventer.
- C. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. 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.
 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Install Y-pattern strainers for water on supply side of each control valves, water pressure-reducing valves, solenoid valves, and pumps.
- G. Set nonfreezing, nondraining-type post hydrants in concrete or pavement.
- H. Set freeze-resistant yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.
- I. Install water-hammer arresters in water piping according to PDI-WH 201.
- J. Install hose bibbs with integral or field-installed vacuum breaker.
- K. Install wall hydrants with integral or field-installed vacuum breaker.

- L. Install trap seal primer valves with valve outlet piping pitched down toward drain trap a minimum of one percent and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- M. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.
- N. Fasten recessed, wall-mounting plumbing specialties to reinforcement built into walls.
- O. Secure supplies to supports or substrate.
- P. Install individual stop valve in each water supply to plumbing specialties. Use ball valve if specific valve is not indicated.
- Q. Install water-supply stop valves in accessible locations.
- R. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.
- S. Include wood-blocking reinforcement for recessed and wall-mounting plumbing specialties.

2.16 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
 - 1. Install piping connections between plumbing specialties and piping specified in other Division 22 Sections.
 - 2. Install piping connections indicated between appliances and equipment specified in other Sections; connect directly to plumbing piping systems.
 - 3. Supply Runouts to Plumbing Specialties: Install hot- and cold-water-supply piping of sizes indicated, but not smaller than required by authorities having jurisdiction.

PART 3 - EXECUTION

NOT APPLICABLE

END OF SECTION 22 11 19

SECTION 22 13 19 – SANITARY AND STORM PIPING SPECIALTIES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Grease Trap
- B. Cleanouts
- C. Floor Drains
- D. Drainage Piping Specialties

1.2 RELATED WORK

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISIONS FOR PLUMBING WORK
- C. Section 221000 - PLUMBING PIPING AND VALVES
- D. Section 224200 - PLUMBING FIXTURES AND EQUIPMENT

1.3 REFERENCES

- A. ASTM C478 - Precast Reinforced Concrete Manhole Sections

1.4 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.
- B. Products listed in schedule on drawings shall determine quality and grade required. If other than those listed in schedule are to be used, equivalent or parallel grade shall be used.
- C. All drains shall be constructed of the finest quality cast iron, coated with the manufacturer's standard protective paint, and furnished with all items specified.

1.5 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 GREASE TRAP

- A. Provide a precast concrete Grease Trap as detailed on Drawings. Grease Trap shall be cast using 4500 psi concrete with required reinforcing.
- B. Openings for manholes and pipe connections shall be cast into Grease Trap.
- C. Cast iron frame and cover with 22-1/2 dia. opening and 7" high frame. Manufacturers offering products complying with requirements include:
 - 1. Neenah; R-1786
 - 2. Clow Co.
 - 3. J.R. Hoe Co.
- D. Holding capacity shall be 1000 gallons minimum.

2.2 CLEANOUTS

- A. Provide cleanouts as detailed and specified on Drawings. Cleanout types are as follows:
 - 1. Exposed Cast Iron Cleanouts
 - 2. Cast Iron Floor Cleanouts
 - 3. Cast Iron Wall Cleanouts
- B. Manufactured by Josam, MIFAB, J.R. Smith, Sioux Chief, Wade, Watts, and Zurn.

2.3 FLOOR DRAINS

- A. Provide floor drains as detailed and specified on Drawings. Floor drain types are as follows:
 - 1. Cast Iron Floor Drains
 - 2. Manufactured by Josam, MIFAB, J.R. Smith, Sioux Chief, Wade, Watts, and Zurn.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- A. Open Drains (receptacles):
 - 1. Description: Shop or field fabricated from ASTM A 74, Service class hub-and-spigot cast-iron, soil-pipe fittings or Schedule 40 PVC. Include P-trap, hub-and-spigot riser section: and where required, increaser fitting.
- B. Floor Drain, Trap-Seal Primer Fittings
 - 1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection. Size: Same as floor drain outlet with NPS ½ side inlet.
- C. Air-Gap Fittings
 - 1. ASME A112.1.12, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping. Bronze or cast-iron body.

PART 3 - EXECUTION

- 3.1 Install specialties in accordance with manufacturer's instructions to permit intended performance.
 - A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
 - B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
 - C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
 - D. 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.

2. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - E. Assemble open drain fittings and install with top of hub 1 inch above floor.
 - F. 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.
 - G. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
 - H. Install grease 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 floor, unless otherwise indicated.
 2. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
 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.
 - I. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
 1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 2. Position roof drains for easy access and maintenance.
- 3.2 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

SECTION 22 14 29 – SUMP PUMPS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Submersible, Fixed-Position, Single –Seal Sump Pumps

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISIONS FOR PLUMBING WORK
- C. Section 221000 - PLUMBING PIPING AND VALVES

1.3 ACTION SUBMITTALS

- A. Shop Drawings: For each pump.
 - 1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Approved Shop Drawings: For all pumps and related components. Provide in operation and maintenance manual.
- B. Operation and Maintenance Data: For pumps to include in operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Armstrong, Bell & Gossett, Champion, Crane, Ebara, Flo Fab, Gould, Little Giant, Peerless, Vertiflo, Weil, and Zoeller.

2.2 GENERAL CHARACTERISTICS

- A. Statically and dynamically balance rotating parts.
- B. Pumps to operate at 1750 rpm maximum unless specified otherwise.
- C. Provide all pumps 1/3 hp and larger with H.O.A. starters with 120V control transformer. See Section 220100 for details.
- D. Integral phase failure relay shall be provided as a part of all three phase motor starters. Relay shall shut motor down on phase loss or phase unbalance and automatically reset when normal phasing is restored. Phase failure relay shall have adjustable restart time capabilities. Mechanical contractor shall coordinate staggered restart times as required.

2.3 SUBMERSIBLE, FIXED-POSITION, SINGLE SEAL SUMP PUMPS

- A. Description: Factory-assembled and -tested sump-pump unit, (simplex or duplex arrangement as specified).
- B. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump.

- C. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
- D. Impeller: Statically and dynamically balanced, ASTM B 584, cast bronze, semi open design for clear wastewater handling, and keyed and secured to shaft.
- E. Pump and Motor Shaft: Stainless steel or steel, with factory-sealed, grease-lubricated ball bearings.
- F. Seal: Mechanical.
- G. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
- H. Controls:
 - 1. Enclosure: NEMA 250, pedestal or wall mounted.
 - 2. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
 - 3. Automatic Alternator (for duplex arrangements): Start pumps on successive cycles and start multiple pumps if one cannot handle load.
 - 4. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.
- I. Control-Interface Features:
 - 1. Remote Alarm Contacts: For remote alarm interface.
 - 2. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
 - a. On-off status of pump.
 - b. Alarm status.

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

- A. Install pumps in a manner to provide access to motors, impellers, couplings, and accessories for periodic maintenance.
- B. Pumps shall be independently supported as well as associated piping so that pump is not supported by piping and piping is not supported by pump.

3.2 CONNECTIONS

- A. See drawings and other Division 22 specifications for installation requirements and arrangement of piping, fittings, and specialties.
- B. Install all piping at pumps in a manner too allow for service and maintenance of pumps.
- C. At piping connections to pumps, install valves the same size as piping.
 - 1. For sump pumps, install check and shut-off valves on discharge piping.

3.3 DEMONSTRATION

- A. Provide owner's maintenance personnel training as required to adjust, operate, and maintain pumps.

END OF SECTION 22 14 29

SECTION 22 33 00 – ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Electric, Storage, Domestic Water Heaters
- B. Electric, Tankless, Domestic Water Heater
- C. Expansion Tank

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISIONS FOR PLUMBING WORK
- C. Section 221000 - PLUMBING PIPING AND VALVES

1.3 QUALITY ASSURANCE

- A. Ensure products and installation of specified products are in conformance with recommendations and requirements of the following organizations:
 - 1. National Sanitation Foundation (NSF)
 - 2. American Society of Mechanical Engineers (ASME)
 - 3. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI)
 - 4. National Electrical Manufacturers' Association (NEMA)
 - 5. Underwriters Laboratories (UL)

1.4 ACTION SUBMITTALS

- A. Shop Drawings: For each product.
 - 1. Product Data:
 - a. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Approved Shop Drawings: For each type of product and related components. Provide in operation and maintenance manual.
- B. Operation and Maintenance Data: For each type of product and controls to include in operation, and maintenance manuals.

1.6 WARRANTY

- A. Provide five (5) year warranty on all electric, storage domestic water heaters, controls, and other components.
- B. Provide five (5) year warranty on all electric, tankless domestic water heaters.
- C. Provide five (5) year warranty on all expansion tanks.

PART 2 - PRODUCTS

2.1 ELECTRIC, STORAGE, DOMESTIC WATER HEATER

- A. Acceptable Manufacturers
 - 1. State, A.O. Smith, Lochinvar, PVI, Rheem or Precision electric water heater of size as shown on drawings.
- B. Standard: UL 1453. Storage Tank Construction: ASME-code (where required), steel vertical arrangement.
 - 1. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
 - a. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - b. NPS 2-1/2 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.
 - 2. Pressure Rating: 150 psig.
 - 3. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining material into tappings.
- C. Factory-Installed Storage Tank Appurtenances:
 - 1. Anode Rod: Replaceable magnesium.
 - 2. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - 3. Insulation: Comply with ASHRAE/IESNA 90.1.
 - 4. Jacket: Steel with enameled finish.
 - 5. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
 - 6. Temperature Control: Adjustable thermostat.
 - 7. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
 - 8. 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.
- D. Provide ASME rating on all water heaters with an input rating of 200,000 Btuh and above.
- E. See schedule on drawing.

2.2 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS

- A. Acceptable Manufacturers
 - 1. A.O. Smith, Chronomite, Eemax, Bosch, Steibel-Eltron
- B. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
- C. Construction: Copper piping or tubing complying with NSF 61 Annex G barrier materials for potable water, without storage capacity.
 - 1. Connections: ASME B1.20.1 pipe thread.
 - 2. Pressure Rating: 150 psig.
 - 3. Heating Element: Resistance heating system.

4. Temperature Control: Flow-control fitting or thermostat.
5. Safety Control: High-temperature-limit cutoff device or system.
6. Jacket: Aluminum or steel with enameled finish or plastic.
7. Support: Bracket for wall mounting.

2.3 DIAPHRAGM - TYPE EXPANSION TANKS

- A. Acceptable Manufacturers
 1. Amtrol, State Taco, or Watts for potable water.
- B. Description
 1. Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
- C. Construction:
 1. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 2. Interior Finish: Comply with NSF 61 Annex barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 3. Air-Charging Valve: Factory installed.

PART 3 - EXECUTION

3.1 DOMESTIC WATER HEATER INSTALLATION

- A. Install water heaters in accordance with manufacturer's instructions and to all relevant NFPA, ASME and NSP requirements.
- B. Electric, Storage Domestic-Water Heater Mounting: Install domestic-water heaters on concrete base. Comply with requirements for concrete base.
 1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 2. Maintain manufacturer's recommended clearances.
 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 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.
- C. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters at least 18 inches 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.
- D. 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.
- E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend 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.
- G. Install thermometer on outlet piping of domestic-water heaters.
- 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.

END OF SECTION 22 33 00

SECTION 22 34 00 – FUEL FIRED DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Gas-Fired, High Efficiency, Storage, Domestic Water Heaters
- B. Expansion Tank
- C. Venting

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISIONS FOR PLUMBING WORK
- C. Section 221000 - PLUMBING PIPING AND VALVES

1.3 QUALITY ASSURANCE

- A. Ensure products and installation of specified products are in conformance with recommendations and requirements of the following organizations:
 - 1. National Sanitation Foundation (NSF).
 - 2. American Society of Mechanical Engineers (ASME).
 - 3. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
 - 4. National Electrical Manufacturers' Association (NEMA).
 - 5. Underwriters Laboratories (UL).
 - 6. American Gas Association (AGA)
 - 7. National Fire Protection Association (NFPA)

1.4 ACTION SUBMITTALS

- A. Shop Drawings: For each product.
 - 1. Product Data:
 - a. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Approved Shop Drawings: For each type of product and related components. Provide in operation and maintenance manual.
- B. Operation and Maintenance Data: For each type of product and controls to include in operation, and maintenance manuals.

1.6 WARRANTY

- A. Provide five (5) year warranty on all fuel fired, storage domestic water heaters, controls, and other components.
- B. Provide five (5) year warranty on all fuel fired, tankless domestic water heaters.
- C. Provide five (5) year warranty on all expansion tanks.

PART 2 - PRODUCTS

2.1 GAS-FIRED, HIGH-EFFICIENCY, STORAGE DOMESTIC WATER HEATER

- A. Acceptable Manufacturers
 - 1. State, A.O. Smith, Rheem, PVI, or Lochinvar, gas water heater of size as shown on drawings.
- B. Standard: ANSI Z21.10.3/CSA 4.3. Manufacturer's proprietary design to provide at least 95 percent minimum combustion efficiency at optimum operating conditions.
- C. Storage-Tank Construction: ASME-code steel with 150-psig minimum working pressure rating.
 - 1. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
 - a. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - b. NPS 2-1/2 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.
 - 2. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - 3. Lining: Glass lined complying with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
- D. Factory-Installed Storage-Tank Appurtenances:
 - 1. Anode Rod: Replaceable magnesium.
 - 2. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - 3. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
 - 4. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
 - 5. Jacket: Steel with enameled finish.
 - 6. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters, and natural-gas fuel.
 - 7. Temperature Control: Adjustable thermostat.
 - 8. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
 - 9. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. 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.
- E. Provide ASME rating on all water heaters with an input rating of 200,000 Btuh and above.

2.2 GAS-FIRED, TANKLESS, DOMESTIC WATER HEATERS

- A. Acceptable Manufacturers
 - 1. Bosch, Lochinvar, Noritz, Rheem, Rinnia, A.O. Smith, State and Takagi, gas water heater of size as shown on drawings.

- B. Standard: ANSI Z21.10.3/CSA 4.3 for gas-fired, instantaneous, domestic-water heaters for indoor application.
- C. Construction: Copper piping or tubing complying with NSF 61 Annex G barrier materials for potable water, without storage capacity.
 - 1. Tappings: ASME B1.20.1 pipe thread.
 - 2. Pressure Rating: 150 psig.
 - 3. Heat Exchanger: Copper tubing.
 - 4. Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2.
 - 5. Jacket: Metal, with enameled finish, or plastic.
 - 6. Burner: For use with tankless, domestic-water heaters and natural-gas or LP-gas fuel.
 - 7. Automatic Ignition: Manufacturer's proprietary system for automatic, gas ignition.
 - 8. Temperature Control: Adjustable thermostat.
- D. Support: Bracket for wall mounting.

2.3 DIAPHRAGM - TYPE EXPANSION TANKS

- A. Acceptable Manufacturers
 - 1. Amtrol, State, Taco or Watts for potable water.
- B. Construction: Welded steel, tested and stamped in accordance with Section 8D of ANSI/ASME Code; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.

PART 3 - EXECUTION

3.1 DOMESTIC WATER HEATER INSTALLATION

- A. Install water heaters in accordance with manufacturer's instructions and to all relevant NFPA, ASME and NSP requirements.
- B. Storage Domestic Water Heater Mounting: Install domestic-water heaters on concrete base. Comply with requirements for concrete base.
 - 1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 - 2. Maintain manufacturer's recommended clearances.
 - 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 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.

- C. Tankless, Domestic-Water Heater Mounting: Install tankless, domestic-water heaters at least 18 inches 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.
- D. 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.
- E. Install gas-fired, domestic-water heaters according to NFPA 54.
 - 1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
 - 2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
 - 3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
- F. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend 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.
- G. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains.
- H. Install thermometer on outlet piping of domestic-water heaters.
- I. 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.

END OF SECTION 22 34 00

SECTION 22 42 00 – PLUMBING FIXTURES AND EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Water Closets
- B. Urinals
- C. Lavatories
- D. Electric Water Coolers
- E. Mop Basins
- F. Showers
- G. Shower Trim

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISIONS FOR PLUMBING WORK
- C. Section 211000 - PLUMBING PIPING AND VALVES

1.3 ACTION SUBMITTALS

- A. Shop Drawings: For each fixture.
 - 1. Product Data: For each type of product.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Include diagrams for power, signal, and control wiring where applicable.

1.4 CLOSEOUT SUBMITTALS

- A. Approved Shop Drawings: For each type of product and related components requiring maintenance. Provide in operation and maintenance manual.
- B. Operation and Maintenance Data: Provide in operation and maintenance manual the following when provided:
 - 1. Flushometer valves and electronic sensors.
 - 2. Lavatory, sink and shower faucets.
 - 3. Electric water coolers.

1.5 GENERAL REQUIREMENTS

- A. All plumbing fixtures and their installation shall conform to the requirements of the Kentucky State Plumbing Code.
- B. Exposed metal work shall be bright chrome-plated brass except as noted.
- C. All fixtures shall be by the same manufacturer.

- D. All ADA accessible water closets provided with manual flush valve/trip lever shall have the flush valve handle/trip lever mounted on the wide(open) side of the water closet.
- E. All drinking water system components that convey or dispense water for human consumption through drinking or cooking shall be "lead-free" in accordance with NSF/ANSI 61 and/or NSF/ANSI 372 standards and all state and local requirements.
- F. Provide all plumbing fixtures complete with trim required and connect in a manner conforming to the state and local plumbing codes. Certain fixtures will be furnished by others under other sections of these Specifications. Provide rough-in and final connections including all valves, traps, specialties, etc. required.
- G. Provide traps for all waste connections where not furnished with the fixture and or equipment; unions; and stops or shut-off valves for all water connections to all sinks and other items of equipment as required. All exposed pipe and metal, including that within cabinets, shall be chrome plated brass.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Acorn, Amtecko, Aqua, American Standard, Bemis, Bradley, Briggs/Proflo, Chicago, Clarion Bathware, Church, Comfort Design, Compass, Component Hardware, Delany, Delta, Eljer, Elkay, Encon, Fiat, Florestone, Guardian, Haws, Intersan, Jay R. Smith, Just, Josam, Kohler, Lawler, Leonard, Metcraft, Mifab, Moen, Murdock, Mustee, Oasis, Olsonite, Powers, PPP, Sioux Chief, Sloan, Speakman, Stearn-Williams, Stingray Systems, Symmons, T&S Brass, Taco, Toto, Willoughby, Wade, Watersaver, Watts and Zurn. SEE SCHEDULES ON DRAWINGS.
- B. Products listed in schedule on drawings shall determine quality and grade required. If other than those listed in schedule are to be used, equivalent or parallel grade shall be used.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for potable, hot- and cold-water supply piping systems; soil, waste, and vent piping systems; and supports. Verify that locations and sizes of piping and locations and types of supports match those indicated, before installing and connecting fixtures. Use manufacturer's roughing-in data when roughing-in data are not indicated.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PLUMBING FIXTURE INSTALLATION

- A. Assemble plumbing fixtures and trim, fittings, faucets, and other components according to manufacturers' written instructions.
- B. Install fixtures level and plumb according to manufacturers' written instructions, roughing-in drawings, and referenced standards.
- C. Install floor-mounted, back-outlet water closets with fittings and gasket seals.
- D. Install wall-hanging, back-outlet water closets with support manufacturer's tiling frame or setting gage.
- E. Install toilet seats on water closets.
- F. Install wall-hanging, back-outlet urinals with gasket seals.

- G. Install flush valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for handicapped people to reach.
- H. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.
- I. Fasten recessed, wall-mounted fittings to reinforcement built into walls.
- J. Fasten wall-mounted fittings to reinforcement built into walls.
- K. Fasten counter-mounting plumbing fixtures to casework.
- L. Secure supplies to supports or substrate within pipe space behind fixture.
- M. Set shower receptors and mop basins in leveling bed of cement grout as specified by Architect.
- N. Install individual stop valve in each water supply to fixture. Use gate or globe valve where specific stop valve is not specified.
- O. Exception: Omit stop valves on supplies to emergency equipment, except when permitted by authorities having jurisdiction. When permitted, install valve chained and locked in OPEN position.
- P. Install water-supply stop valves in accessible locations.
- Q. Install faucet, laminar-flow fittings with specified flow rates and patterns in faucet spouts when faucets are not available with required rates and patterns. Include adapters when required.
- R. Install supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.
- S. Install shower, flow-control fittings with specified maximum flow rates in shower arms.
- T. Install traps on fixture outlets. Omit traps on fixtures having integral traps. Omit traps on indirect wastes, except where otherwise indicated.
- U. Install disposers in sink outlets. Install switch where indicated, or in wall adjacent to sink if location is not indicated.
- V. Install escutcheons at wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.
- W. Seal joints between fixtures and walls, floors, and counters using sanitary-type, 1-part, mildew-resistant, silicone sealant. Coordinate this requirement with Architectural trades.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
- B. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other Division 22 Sections.
- C. Supply and Waste Connections to Plumbing Fixtures: Refer to plumbing fixture schedules for fitting sizes and connection requirements for each plumbing fixture.
- D. Supply and Waste Connections to Equipment Specified in Other Sections: Connect equipment with supply inlets, supply stops, supply risers, and traps specified in this Section. Use fitting sizes required to match connected equipment. Connect fittings to plumbing piping.

- E. Arrange for electric-power connections to fixtures and devices that require power. Electric power is specified in Division 26 Sections and individual equipment sections.

3.4 FIELD QUALITY CONTROL

- A. Verify that installed fixtures are categories and types specified for locations where installed.
- B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized and demonstrate proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING AND CLEANING

- 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 drinking fountains, electric water coolers, faucets, shower valves, and flushometer valves having controls, to produce proper flow and stream.
- D. Replace washers and seals of leaking and dripping faucets and stops.
- E. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Include the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.

3.6 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities, except when approved in writing by Owner.

END OF SECTION 22 42 00

SECTION 22 42 01 – WATER BOTTLE FILLING STATIONS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Water Bottle Filling Stations

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISIONS FOR PLUMBING WORK
- C. Section 211000 - PLUMBING PIPING AND VALVES

1.3 GENERAL REQUIREMENTS

- A. All water bottle filling stations and their installation shall conform to the requirements of the Kentucky State Plumbing Code.
- B. Exposed metal work shall be bright chrome-plated brass except as noted.
- C. All water bottle filling stations shall be by the same manufacturer.
- D. All water bottle filling stations shall have a filter on water supply.
- E. All drinking water system components that convey or dispense water for human consumption through drinking or cooking shall be "lead-free" in accordance with NSF/ANSI 61 and/or NSF/ANSI 372 standards and any and all state and local requirements.
- F. Provide all water bottle filling stations complete with trim required and connect in a manner conforming to the state and local plumbing codes. Certain fixtures will be furnished by others under other sections of these Specifications. Provide rough-in and final connections including all valves, traps, specialties, etc. required.
- G. Provide traps for all waste connections where not furnished with the fixture and or equipment; unions; and stops or shut-off valves for all water connections to all water bottle filling stations as required. All exposed pipe and metal, including that within cabinets, shall be chrome plated brass.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Elkay, Halsey-Taylor, Murdock, Oasis SEE CUT SHEETS OF ACCEPTABLE PRODUCT AT THE END OF THIS SPECIFICATION. SEE SCHEDULES ON DRAWINGS.
- B. Products listed in schedule on drawings shall determine quality and grade required.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for potable, hot- and cold-water supply piping systems; soil, waste, and vent piping systems; and supports. Verify that locations and sizes of piping and locations and types of supports match those indicated, before installing and connecting fixtures. Use manufacturer's roughing-in data when roughing-in data are not indicated.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 WATER BOTTLE FILLING STATION INSTALLATION

- A. Assemble water bottle filling stations, and other components according to manufacturers' written instructions.
- B. Install water bottle filling stations level and plumb according to manufacturers' written instructions, roughing-in drawings, and referenced standards.
- C. Fasten water bottle filling stations securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.
- D. Secure supplies to supports or substrate within pipe space behind water bottle filling stations.
- E. Install individual stop valve in each water supply to water bottle filling stations. Use gate
- F. Install water-supply stop valves in accessible locations.
- G. Install traps on water bottle filling stations outlets.
- H. Install escutcheons at wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.
- I. Seal joints between water bottle filling stations and walls, floors, and counters using sanitary-type, 1-part, mildew-resistant, silicone sealant. Coordinate this requirement with Architectural trades.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
- B. Install piping connections between water bottle filling stations and piping systems and plumbing equipment specified in other Division 22 Sections.
- C. Supply and Waste Connections to water bottle filling stations: Refer to plumbing fixture schedules for fitting sizes and connection requirements for each plumbing fixture.
- D. Arrange for electric-power connections to water bottle filling stations that require power. Electric power is specified in Division 26 Sections and individual equipment sections.

3.4 FIELD QUALITY CONTROL

- A. Verify that installed water bottle filling stations are categories and types specified for locations where installed.
- B. Check that water bottle filling stations are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed water bottle filling stations for damage. Replace damaged fixtures and components.
- D. Test installed water bottle filling stations after water systems are pressurized and demonstrate proper operation. Replace malfunctioning water bottle filling stations and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING AND CLEANING

- A. Operate and adjust controls. Replace damaged and malfunctioning water bottle filling stations, fittings, and controls.
- B. Adjust water pressure at water bottle filling stations, to produce proper flow and stream.
- C. Replace washers and seals of leaking and dripping faucets and stops.

D. Clean water bottle filling stations with manufacturers' recommended cleaning methods and materials. Include the following:

1. Remove filters, strainers, and spouts, remove sediment and debris, and reinstall filters, strainers, and spouts.
2. Remove sediment and debris from drains.

3.6 PROTECTION

A. Provide protective covering for installed water bottle filling stations and fittings.

B. Do not allow use of water bottle filling stations for temporary facilities, except when approved in writing by Owner.

END OF SECTION 22 42 01



DRINKING FOUNTAIN

A172UBL Series MODEL A172100F-UBL-BF1S BARRIER FREE, WALL MOUNTED UNIVERSAL BI-LEVEL WITH -BF1S PUSHBUTTON OPERATED BOTTLE FILLER

STANDARD FEATURES

- Child or Adult ADA Compliant (when properly installed)
- Universal Bi-Level-Can be installed left high or right high with no additional parts
- Granite Powder Coated Apron and One-Piece Bottom Wrapper
- Flexible, Low Flow, Anti-Rotation, Non-Squirt Bubbler
- 100-Mesh Inlet Strainer
- Vandal Resistant Screws
- Hanging Bracket provided
- Auto-stop allows service of Cartridge and Strainer without shutting off Water Supply Stop
- Laminar Flow Water Supply
- 1 GPM. Fill Rate
- 100% Lead & Brass Free

SUGGESTED SPECIFICATIONS

Model A172100F-UBL-BF1S is a self-contained, Vandal

Resistant Bi-Level Drinking Fountain. Units shall be activated from a Pushbutton in the front, using less than 5 pounds of force. Bubblers shall deliver a 0.3 GPM flow, have a Flexible Guard with an integrally designed non-squirt feature and operate on a water pressure range of 20-105 PSIG. Basins shall be constructed from 304 Stainless Steel and have an Integral Drain. Unit includes model BF1 Pushbutton Operated Bottle Filler. Drinking Fountain Cabinets shall be either Galvanized Steel with Granite Powder Coat or Stainless Steel. Bottle Filler shall be Stainless Steel. Unit is certified to ANSI A117.1, Public Law 111-380 (NO-LEAD), CHSC 116875 and NSF/ANSI 61, Section 9. Fixture meets ADA, ADA Standing Person, and ADA Child requirements when mounted

appropriately.



MODEL:

(Must Specify)

FLEXIBLE BUBBLER

- A172100F-UBL-BF1S Granite Finish
- A172400F-UBL-BF1S Satin Stainless Finish (Shown)

LEAD-FREE STAINLESS STEEL BUBBLER

- A172100S-UBL-BF1S Granite Finish
- A172400S-UBL-BF1S Satin Stainless Finish

OPTIONS

(additional costs may be incurred)

- CSC3 Concealed Support Carrier
- GF1 Glass Filler with Lever Handle
- SK5 Skirt Kit for upper unit
- WF1 1500-gallon capacity, NSF 42+53, 1 micron Lead Reduction Filter

Complies with the following standards:



Member of
U.S. Green
Building
Council



Recyclable
Product



Water
Conserving
Product

WARNING: Cancer and Reproductive Harm - www.P65Warnings.ca.gov

A172UBL-BF1S

Revised: 12/04/18

ELKAY[®]

SPECIFICATIONS

Elkay EZH2O Bottle Filling Station & Versatile Bi-Level ADA Cooler Filtered 8 GPH Stainless Model LZSTL8WSVRSK

PRODUCT SPECIFICATIONS

Elkay ezH2O[®] Bottle Filling Station & Versatile Bi-Level ADA Cooler, Filtered 8 GPH Stainless. Chilling Capacity of 8.0 GPH (gallons per hour) of 50° F drinking water, based on 80° F inlet water and 90° F ambient, per ASHRAE 18 testing. Features shall include Hands Free, Visual Filter Monitor, Filtered, Green Ticker[™], Laminar Flow, Antimicrobial, Real Drain. Furnished with Vandal Resistant bubbler. Electronic Bottle Filler Sensor With Electronic Front And Side Bubbler Pushbar activation. Product shall be Wall Mount (On Wall), for Indoor applications, serving 2 station(s). Unit shall be certified to UL 399 and CAN/CSA C22.2 No. 120. Unit shall be lead-free design which is certified to NSF/ANSI 61 & 372 (lead free) and meets Federal and State low-lead requirements.

Special Features:	Hands Free, Visual Filter Monitor, Filtered, Green Ticker [™] , Laminar Flow, Antimicrobial, Real Drain
Finish:	Stainless Steel
Power:	115V/60Hz
Bubbler Style:	Vandal Resistant
Activation by:	Electronic Bottle Filler Sensor With Electronic Front And Side Bubbler Pushbar
Mounting Type:	Wall Mount (On Wall)
Chilling Option*:	8.0 GPH
Full Load Amps	6
Rated Watts:	370
Dimensions (L x W x H):	36-3/4" x 19" x 39-1/16"
Approx. Shipping Weight:	106 lbs.
Installation Location:	Indoor
No. of Stations Served:	2
*Based on 80° F inlet water & 90° F ambient air temp for 50° F chilled drinking water.	

Special Note: *Coming soon: The Elkay ezH2O you know and love is getting a fresh look, as shown here. In stock models may have prior logo design.

- Visual Filter Monitor: LED Filter Status Indicator for when filter change is necessary.
- Filter is certified to NSF 42 and 53 for lead, particulate, chlorine, taste and odor reduction. 3,000 gal. capacity.
- Green Ticker: Informs user of number of 20 oz. plastic water bottles saved from waste.
- Laminar flow provides clean fill with minimal splash.
- Silver Ion Antimicrobial protection on key plastic components to inhibit the growth of mold and mildew.
- Real Drain System eliminates standing water.

PART: _____ QTY: _____
 PROJECT: _____
 CONTACT: _____
 DATE: _____
 NOTES: _____
 APPROVAL: _____



AMERICAN PRIDE. A LIFETIME TRADITION.

Like your family, the Elkay family has values and traditions that endure. For almost a century, Elkay has been a family-owned and operated company, providing thousands of jobs that support our families and communities.



Included with Product: Water Cooler (LZSTL8WSVRSC), Bottle Filler (LZWSR), Filter

▼ Ships in multiple boxes.

PRODUCT COMPLIANCE

ADA & ICC A117.1
 ASME A112.19.3/CSA B45.4
 Buy American Act
 CAN/CSA C22.2 No. 120
 GreenSpec[®]
 NSF/ANSI 42, 53, 61, & 372 (lead free)
 UL 399



Complies with ADA & ICC A117.1 accessibility requirements when installed according to the requirements outlined in these standards. Installation may require additional components and/or construction features to be fully compliant. Consult the local Authority Having Jurisdiction if necessary.

[Installation Instructions \(PDF\)](#)

5 Year Limited Warranty on the refrigeration system of the unit. Electrical components and water system are warranted for 12 months from date of installation. **Warranty pertains to drinking water applications only. Non-drinking water applications are not covered under warranty.**

[Warranty \(PDF\)](#)

OPTIONAL ACCESSORIES

51300C - WaterSentry Plus Replacement Filter (Bottle Fillers)
LKAPREZL - Elkay Cane Apron for EZ Gray
MLP200 - Accessory - In Wall Carrier (Bi-Level) for bi-level EZ, LZ, EMABF, LMABF, VRC, LVRC models
98568C - WaterSentry Filter Mounting Cover (Stainless Steel)

In keeping with our policy of continuing product improvement, Elkay reserves the right to change product specifications without notice. Please visit elkay.com for the most current version of Elkay product specification sheets. This specification describes an Elkay product with design, quality, and functional benefits to the user. When making a comparison of other producers' offerings, be certain these features are not overlooked.

Elkay REV 07182019
[LZSTL8WSVRSK](#)

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Halsey Taylor

SPECIFICATIONS

Halsey Taylor HydroBoost Bottle Filling Station & Bi-Level ADA Cooler Filtered 8 GPH Stainless Model HTHB-HAC8BLSS-WF

PRODUCT SPECIFICATIONS

Halsey Taylor HydroBoost® Bottle Filling Station, & Bi-Level ADA Cooler, Filtered 8 GPH Stainless. Chilling Capacity of 8.0 GPH (gallons per hour) of 50° F drinking water, based on 80° F inlet water and 90° F ambient, per ASHRAE 18 testing. Features shall include Mechanically Activated, Sanitary Sensor Activated, Visual Filter Monitor, Filtered, Green Counter™, Laminar Flow, Antimicrobial, Real Drain. Furnished with Double Bubbler™. Electronic Bottle Filler Sensor With Mechanical Front And Side Bubbler Pushbar activation. Product shall be Wall Mount (On Wall), for Indoor applications, serving 2 station(s). Unit shall be certified to UL 399 and CAN/CSA C22.2 No. 120. Unit shall be lead-free design which is certified to NSF/ANSI 61 & 372 (lead free) and meets Federal and State low-lead requirements.

Special Features:	Mechanically Activated, Sanitary Sensor Activated, Visual Filter Monitor, Filtered, Green Counter™, Laminar Flow, Antimicrobial, Real Drain
Finish:	Stainless Steel
Power:	115V/60Hz
Bubbler Style:	Double Bubbler™
Activation by:	Electronic Bottle Filler Sensor With Mechanical Front And Side Bubbler Pushbar
Mounting Type:	Wall Mount (On Wall)
Chilling Option*:	8.0 GPH
Full Load Amps	6
Rated Watts:	370
Dimensions (L x W x H):	36-1/4" x 18-5/8" x 46-1/4"
Approx. Shipping Weight:	111 lbs.
Installation Location:	Indoor
No. of Stations Served:	2
*Based on 80° F inlet water & 90° F ambient air temp for 50° F chilled drinking water.	

- Mechanically-Activated bubbler continues to supply water in event of service disruptions.
- Touchless, sensor-activation, designed for easy use.
- Visual Filter Monitor: LED Filter Status Indicator for when filter change is necessary.
- Filter is certified to NSF 42 and 53 for lead, particulate, chlorine, taste and odor reduction. 3,000 gal. capacity.
- Green Counter: Informs user of number of 20 oz. plastic water bottles saved from waste.
- Laminar flow provides clean fill with minimal splash.
- Silver Ion Antimicrobial protection on key plastic components to inhibit the growth of mold and mildew.
- Real Drain System eliminates standing water.

PART: _____ QTY: _____
 PROJECT: _____
 CONTACT: _____
 DATE: _____
 NOTES: _____
 APPROVAL: _____



AMERICAN PRIDE. A LIFETIME TRADITION.

Like your family, the Elkay family has values and traditions that endure. For almost a century, Elkay has been a family-owned and operated company, providing thousands of jobs that support our families and communities.



Included with Product: Water Cooler (8740082883-HTHB), Filter, Bottle Filler (HTHB-HAC)

▼ Ships in multiple boxes.

PRODUCT COMPLIANCE

ADA & ICC A117.1
 ASME A112.19.3/CSA B45.4
 Buy American Act
 CAN/CSA C22.2 No. 120
 GreenSpec®
 NSF/ANSI 42, 53, 61, & 372 (lead free)
 UL 399



Complies with ADA & ICC A117.1 accessibility requirements when installed according to the requirements outlined in these standards. Installation may require additional components and/or construction features to be fully compliant. Consult the local Authority Having Jurisdiction if necessary.

[Installation Instructions \(PDF\)](#)

5 Year Limited Warranty on the refrigeration system of the unit. Electrical components and water system are warranted for 12 months from date of installation. **Warranty pertains to drinking water applications only. Non-drinking water applications are not covered under warranty.**

[Warranty \(PDF\)](#)

In keeping with our policy of continuing product improvement, Halsey Taylor reserves the right to change product specifications without notice. Please visit Halseytaylor.com for the most current version of Halsey Taylor product specification sheets. This specification describes a Halsey Taylor product with design, quality, and functional benefits to the user. When making a comparison of other producers' offerings, be certain these features are not overlooked.

Halsey Taylor REV 07182019
[HTHB-HAC8BLSS-WF](#)

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BI-LEVEL VERSACOOLER® II W/ MECHANICAL BOTTLE FILLER

Energy and Conservation Technology

PG8SBFSL, PG8SBFSL
PG8SBFSL, PG8SBFSL

Suggested Specification

Model PG8SBFSL shall deliver 8.0 gph of 50° F degree water at 90° F ambient and 80° F inlet water. Model PG8SBFSL is a non-refrigerated drinking fountain and delivers ambient water. Both shall include the VersaFiller Sports Bottle Filler with independent manual activation; lower unit must have four antimicrobial copper push pads to activate the manual flow of water for the cooler. VersaFiller components contain Freshield®, which utilizes a silver-based antimicrobial compound that reduces the growth of micro-organisms and mildew to protect the surfaces from discoloration, odors and degradation. Basin shall be designed to eliminate splashing and standing water. Water saver bubbler reduces waste water by 50% and shall have flexible guard and operate between 20 and 100 PSI. Cabinet finish shall be sandstone on galvanized steel or brushed stainless steel. Shall use R-134a refrigerant. Shall comply with ANSI 117.1 and ADA. Shall be listed by Underwriters Laboratories to US and Canadian standards. Shall comply with ANSI/NSF 61 and NSF/ANSI372.

Models

- PG8SBFSL delivers 8.0 gallons of chilled drinking water per hour.
- PG8SBFSL is a non-refrigerated fountain.

Standard Features

- Universal design allows universal installation
- Built-in 100 micron strainer stops particles before they enter the waterway
- Lead-free waterways
- Flexible and one-piece antimicrobial water saver bubbler guard
- Stainless steel top and heavy duty galvanized steel frame
- High efficiency cooling system
- Four antimicrobial copper push pads
- External stream height adjustment on lower unit
- Independent mechanically activated VersaFiller

Finishes

- Standard cabinet finish: Sandstone powder coated paint on galvanized steel
- Optional finishes (at additional cost): Stainless steel

Installation

- Prior to roughing consult with local, state and federal codes for proper mounting height
- Shipped with complete instructions and wall mounting bracket
- Removable side and front panels provide easy access for installation.

Options (at additional cost)

- Antimicrobial chrome plated brass bubbler (036700-001)
- VersaFilter
- Cane apron (035174-001)

Limited 5-Year Warranty

(Continental limits of the United States and Canada)
Five years on the sealed refrigeration system and most component parts. Detailed warranty certificate enclosed with each water cooler; sample available upon request.

Export Warranty

One year on components parts. Detailed warranty certificate enclosed with each drinking fountain; sample copy available upon request.

Certifications/Compliance

- Antimicrobial Copper - EPA Registration No. 89187-3
- Oasis International Electric Water Coolers are listed by Underwriters Laboratories Inc. and comply with both U.S. and Canadian Requirements.
- Product Certified to NSF/ANSI Standard 61-G & 372 and conforms with the lead content requirements for "Lead Free" plumbing as defined by California, Vermont, Maryland, and Louisiana state laws and the U.S. Safe Drinking Water Act.
- This unit complies with ARI standard 1010 Testing, Operating and Rating requirements (electric water coolers only).
- These water coolers comply with the requirements of ADA (Americans with Disabilities Act) when properly installed.



Model	50° F Drinking Water 90° F Ambient Air Temp*			Hot/N Cold Model	115 Volts, 60 HZ			Glass Filler Acc. Option	Cabinet Color Finish	Net Wt. Approx
	Rated Capacity GHP	Base Rate GHP	Pre-Cooler		Compr. HP	Full Load Amps	Rated Watts			
PG8SBFSL	8.0	8.0	No	No	1/4	4.4	450	No	Yes	109 Lbs
PG8SBFSL	Fountain Only							No	Yes	79 Lbs

SECTION 23 01 00 – GENERAL PROVISIONS FOR MECHANICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. This section covers the general arrangement of the mechanical systems and related items to complete the work as shown on the drawings and as specified herein.
- B. The General and Special Conditions and all other Contract Documents are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- C. The Contractor shall familiarize himself with the work of all other trades, general type construction and the relationship of his work to other sections. He shall examine all working drawings, specifications and conditions affecting his work. The Contractor shall visit the premises and thoroughly familiarize himself with all details of the work and working conditions, verify all dimensions in the field and advise the Engineer of any discrepancy before performing any work.
- D. The work shall include complete testing of all equipment and piping at the completion of the work and making any minor connection changes or adjustments necessary for the proper functioning of the system and equipment.
- E. The Contractor shall perform all necessary temporary work during construction.
- F. Work under this section shall conform to all governing codes, ordinances and regulations of the City, County and State.
- G. The Contractor shall be responsible for all errors in fabrication, for the correct fitting, installation and erection of the various mechanical systems as shown on the drawings.
- H. Any materials, labor, equipment, or services not mentioned specifically herein which may be necessary to complete any part of the MEP/FP systems in a substantial manner and in compliance with the requirements stated, implied, or intended in the Plans and/or Specifications, shall be included in the Bid as part of this Contract.
- I. The Contractor shall hold harmless and indemnify the Engineer, Architect, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any Sub-Contractor, any employee, agent or representative.

1.2 SCOPE

- A. This branch of the work includes coordination with all utility companies; agency review fees and all inspection fees; all labor, materials, tools, excavation and backfill and all equipment necessary for the installation of all Heating, Ventilating and Air Conditioning, System as shown on the Drawings and Specifications and/or as required for complete and operating systems. The work shall include starting, balancing, and the necessary and required tests to ensure the proper operation of the complete system.
- B. All work for this project must comply and be in strict accordance with the Kentucky Building Code, Kentucky Plumbing Code, Kentucky Boiler Code, NFPA, ADA, NEC and all local codes and regulations.
- C. In general (as a minimum) all materials and equipment must be installed in strict accordance with manufacturer's requirements; and provided with all required controls, internal fusing, relays, piping connections, electrical connections, ductwork connections, etc., to provide for complete and operable systems.

- D. All equipment shall be manufactured within 24 months of bid date, no exceptions. Any equipment installed outside of this timeframe shall be removed and replaced to meet this requirement at no additional cost to the owner.
- E. The Architect and Engineer do not define the scope of individual trades, Sub-Contractors, material suppliers and vendors. Any sheet numbering system or specification numbering system used which identifies disciplines is solely for the Architect and Engineer's convenience and is not intended to define a Sub-Contractor's scope of work. Information regarding individual trades, Sub-Contractors, material suppliers and vendors may be detailed, described, and indicated at different locations throughout the Contract Documents. No consideration will be given to requests for change orders for failure to obtain and review the complete set of Contract Documents when preparing Bids, prices, and quotations. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the prime contract.
- F. It is the responsibility of the bidder to completely review the Contract Documents. Any interpretation as to design intent or scope shall be provided by the Engineer / Architect. Should an interpretation be required, the bidder shall request clarification not less than ten (10) days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event of any conflict, discrepancy, or inconsistency, the interpretation of the Engineer shall be final.
- G. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, codes, rules, or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten (10) days prior to bid. In the absence of such written notice and by the act of submitting a bid, it shall be understood that the Contractor has included the cost of all required items in the bid, and that will be responsible for the approved satisfactory functioning of the entire system without extra compensations.

1.3 DEFINITIONS AND ABBREVIATIONS

- A. A-E: Shall construe architect and/or engineer. In all situations that involve an architect, it shall construe architect, in all others, engineer.
- B. Bidder: Any person, agency or entity submitting a proposal to any person, agency, or entity for any part of the work required under this contract.
- C. Contract Documents: All documents pertinent to the quality and quantity of work to be performed on the project. Includes but not limited to plans, specifications, instructions to bidders, general and special conditions, addenda, alternates, list of materials, list of sub-Contractors, unit prices, shop drawings, field orders, change orders, cost breakdown, periodical payment requests, etc.
- D. Demolish: Remove and dispose of equipment, and other appurtenances.
- E. Engineer: The consulting mechanical/electrical engineers either consulting to the owners, architects, other engineers, etc.
- F. Furnish: Deliver to the site in good condition and turn over to Contractor responsible for installation.
- G. Install: Install equipment furnished by others.
- H. Indicated: Shown on the drawings or addenda thereto.
- I. Mechanical Contractor: Any Contractor whether bidding or working independently or under the supervision of a General Contractor and/or Construction Manager, and who installs any type of mechanical work.
- J. Mechanical Sub-Contractor: Any Contractor contracted to or employed by the mechanical Contractor for any work required by the mechanical Contractor.

- K. Prime Contractor: The General Contractor (GC) or Construction Manager (CM).
- L. Project: All of the work required under this Contract.
- M. Provide: Furnish and install in complete, tested and in working order.
- N. System: A term capturing the entire composition of equipment and appurtenances required for a complete, operational, "turnkey" product (i.e. – a geothermal heat pump "system" refers to all heat pumps, ductwork and air devices, piping, well field, make-up water, water fill, chemical feed, hydronic pumps and associated VFDs, electrical wiring and connections, temperature controls and associated wiring, etc.).
- O. Typical (TYP): Where indicated repeat this work, method or means each time the same or similar condition occurs whether indicated or not.
- P. ADA - Americans with Disabilities Act
- Q. AGA - American Gas Association
- R. AMCA - Air Moving and Conditioning Association
- S. ANSI - American National Standards Institute
- T. ARI - Air Conditioning & Refrigeration Institute
- U. ASME - American Society of Mechanical Engineers
- V. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers
- W. ASTM - American Society of Testing Materials
- X. AWWA - American Water Works Association
- Y. AWS - American Welding Society
- Z. BOCA - Building Officials & Code Administrators International, Inc.
- AA. CM - Construction Manager
- BB. DOE - U.S. Department of Energy
- CC. EPA - Environmental Protection Agency
- DD. FM - Factory Mutual
- EE. GC - General Contractor
- FF. HBC - Housing, Building and Construction
- GG. IBC - International Building Code
- HH. IECC - International Energy Conservation Code
- II. IMC - International Mechanical Code
- JJ. MEP/FP - Mechanical, Electrical, Plumbing / Fire Protection
- KK. NFPA - National Fire Protection Association
- LL. NEC - National Electrical Code
- MM. NEMA - National Electrical Manufacturer's Association
- NN. OSHA - Occupational Safety and Health Administration
- OO. SC - Sub-Contractor
- PP. SMACNA - Sheet Metal and Air Conditioning Contractors National Association

QQ. STW - Shrout Tate Wilson Consulting Engineers

RR. UL - Underwriter's Laboratories, Inc.

1.4 QUALIFICATIONS

- A. All Mechanical Contractors and their Sub-Contractors bidding this project must have been a licensed company for a minimum of three (3) years. Experience of any one individual employee does not supersede this requirement.
- B. All mechanical Sub-Contractors bidding the mechanical work must have completed one project of 75% this subcontract cost size and two projects of 50% this subcontract cost size.
- C. All mechanical work shall be performed by qualified workers who are competent in the area of work for which they are responsible. Any workers not meeting this requirement, as evidenced by their workmanship, shall be summarily relieved of their responsibilities. The Engineer shall reserve the right to determine the quality of workmanship of any workers and unqualified or incompetent workers shall refrain from work in areas not deemed satisfactory. Requests for relief of workers shall be made through the normal channels of Architect, Contractor, etc.
- D. The Contractor shall be licensed in the State which the work is to be performed. All work shall be performed by licensed Master HVAC Contractors and Master / Journeymen Plumbers.
- E. All control systems shall be installed by workers normally engaged or employed in this type of work.
- F. Specialized systems such as medical gases, automatic sprinkler systems, etc. shall be installed only by workers who are licensed and normally engaged in such services.
- G. All electrical work shall be accomplished by Licensed Journeymen electricians under the direct supervision of a licensed Electrician. All applicable codes, utility company regulations, laws and permitting authority of the locality shall be fully complied with by the Contractor.

1.5 PERMITS, FEES, CODES AND APPROVALS

- A. Permits and Fees
 - 1. All permits, tap on fees and agency review and inspection fees necessary for the complete HVAC, system shall be obtained by the Contractor from the authorities governing such work. The cost of all permits shall be borne by the Contractor.
- B. Codes
 - 1. The minimum standard for all mechanical work shall be the current requirements of the Kentucky State Plumbing Law, Regulation and Code, Kentucky Building Code, ADA, International Mechanical Code, Kentucky Boiler Code, NFPA and local ordinances.
- C. Approvals
 - 1. All work must be approved by the Architect/Engineer, Owner and all related Code Agencies before final payment will be made.
 - 2. As a minimum, the following approval Certificates of Inspection and Approval shall be required:
 - a. HVAC Inspection
 - b. Local and State Building Inspections.

3. Final payment will be contingent upon all Approval Certificates.

1.6 DRAWINGS AND SPECIFICATIONS

- A. Contract drawings for work under this section are in part diagrammatic, intended to convey the scope of work and indicate the general arrangement of equipment, piping and the approximate size and location of equipment and outlets. The Contractor shall follow these drawings in laying out his work and shall verify spaces in which his work will be installed, indicating to the Engineer where any conflicts or overlapping of systems occur. Any item of work not clearly included, specified and/or shown, errors or conflict between Plans (Mechanical, Architectural, Structural or Electrical), Specifications, codes and field conditions, shall be clarified by a written request to the Architect by the Bidder before bidding; otherwise, the bidder shall, at his own expense, supply the proper labor and materials to include these items of work and to make good any damages or defects in his work caused by such error, omission or conflict. Under no circumstances shall a Contractor scale the Drawings for the location of equipment and work.
- B. In the event there is a conflict within the Contract Documents, the Contractor shall notify the Engineer immediately. If a clarification is not given, the Contractor shall bid the more stringent of the two requirements.
- C. Should conflict, overlap or duplication of work between the various trades become evident, this shall be called to the attention of the Engineer. Neither trade shall assume to be relieved of the work which is specified under their branch until instructions in writing are received from the Engineer.
- D. Where job conditions require reasonable changes in indicated locations and arrangement, proposed departures shall be submitted with detailed drawings to the Engineer for approval before any of the proposed work is commenced. All approved departures shall be made at no additional cost to the Owner.
- E. The drawings and the specifications are intended to indicate complete and working systems, unless specifically indicated to the contrary. The work includes the furnishing, installing, and connecting of a complete working installation in each case to the full extent set forth in the drawings and herein specified. The Contractor shall be responsible for the complete functioning system, unless specifically noted otherwise.
- F. The drawings and specifications constitute the Contract Documents and shall be considered as cooperative. Work and material included in either, though not mentioned in both, shall be a part of the work to be accomplished and shall be carried out completely in as thorough manner as if covered by both. All items shown on the drawings and/or listed in the specifications shall be provided and installed by the Contractor unless specifically noted that it will be provided and/or installed by others. In the event there is a conflict within the Contract Documents, the Contractor shall notify the Engineer immediately. If a clarification is not given, the Contractor shall bid the more stringent of the two requirements.
- G. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings and accessories that may be required. The Contractor shall carefully investigate the structural and finish conditions affecting all his work and shall arrange such work, accordingly, furnishing such fittings, pipe, traps, valves, and accessories as may be required to make a functional installation at no additional cost to the Owner.
- H. Mechanical as built "Record Drawings" shall be kept up to date each day. "Record Drawings" shall be reviewed by Architect/Engineer each month with Contractor's pay request review.
- I. Any deviation in work as shown on plans and specifications must be approved in writing by Architect/Engineer prior to installation.

- J. Each Contractor shall refer to the Architectural and Structural Drawings and Specifications for the general construction of the building, for floor and ceiling heights, for location of walls, partitions, beams etc., and shall be guided accordingly for the setting of all sleeves and equipment.
- K. Under no circumstances shall a Contractor scale the Drawings for the locations of equipment and work.

1.7 EQUIPMENT DESIGN AND INSTALLATION

- A. The design, manufacture, testing and method of installation of all apparatus and materials furnished under the requirements of these specifications shall conform to the applicable standard rules of the following. Where materials are not specifically referred to, but are required, they shall meet the requirements of the applicable code.
- B. Unless otherwise specified, equipment and materials of the same type and used for the same purpose, shall be products of the same manufacturer.
- C. Each Contractor shall demand and examine all Drawings and Specifications pertaining to the construction before installing the work described and shown under these Drawings and Specifications. Each Contractor shall cooperate with all other Contractors in locating piping, openings, chases, and equipment in order to avoid conflict with any other Contractor's work. It is the responsibility of all trades to examine all shop drawings of other trades that would require equipment to occupy the same space and plane within the building to eliminate any potential conflicts. No extra payment will be allowed for relocation of piping, and equipment not installed in accordance with the above instructions, and which interferes with work and equipment of other Contractors.
- D. All appliances, materials and equipment shall be installed and connected in accordance with the best engineering practice and in accordance with the manufacturer's instructions and recommendations. All auxiliary piping, special controls, water seals, valves, electrical connections, drains, etc., recommended by the manufacturer, required for proper operation, or required by code shall be furnished and installed complete.
- E. All equipment designed and constructed for indoor use shall not be shipped to the site until such time that the equipment is ready for permanent installation in a dry building or may be stored on site provided equipment is stored in a water and moisture tight storage building or job trailer. Covering equipment outdoors with plastic or tarp is not acceptable.
- F. All materials and equipment so indicated and all equipment and materials for the electrical portion of the mechanical systems shall bear the approval label of or shall be listed by the Underwriters' Laboratories (UL), Incorporated. Each packaged assembly shall be approved as a package. Approval of components of a package shall not be acceptable.
- G. All Contractors shall familiarize themselves with the entire set of contract documents. Specifically, but not limited to ceiling heights specified on Architectural Plans. Where the location of equipment or systems may interfere with ceiling heights or maintenance and access of equipment or systems, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Do not install equipment or systems in the affected area until the conflict is resolved. Any such changes shall be anticipated and requested sufficiently in advance to prevent extra work or cost incurred on the part of the Contractor or unduly delay the work.
- H. When any Contractor requests approval of materials and/or equipment of different physical size, weight, capacity, function, color, access, that the design allows for it shall be understood that such substitution, if approved, will be made without additional cost to anyone other than the Contractor requesting the change regardless of changes in connections, space requirements, electrical characteristics, etc. from that indicated. In all cases where substitutions affect other trades, the Contractor requesting such substitutions shall advise all such Contractors of the change and shall compensate them

for all necessary changes in their work. Any Plans, Specifications, Diagrams, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense. Review of Shop Drawings by the Engineer does not in any way absolve the Contractor of this responsibility.

- I. Coordinate kitchen equipment selection by the General Contractor prior to Bid. Any deviations and/or conflicts for any kitchen equipment shall be the Contractor's responsibility.
- J. The Contractor's work lines, and established heights shall be in strict accordance with drawings and specifications insofar as these drawings and specifications extend. The Contractor shall verify all dimensions shown and establish all elevations and detail dimensions not shown. The Contractor shall also correlate the time so that the work will proceed to the best advantage of the complete job as a unit. The Contractor shall be responsible for furnishing in ample time, any information required to revise footing elevations, build all chases and openings in floors, walls, partitions, ceilings, and roofs to provide clearance which may be required to accommodate the work. The Contractor shall set all sleeves, anchor bolts and inserts required to accommodate his equipment before masonry is constructed.
- K. The Contractor shall layout his work well enough in advance to foresee any conflicts or interferences with work of other sections so that in case of interference, his layout may be altered to suit the conditions, prior to the installation of any work. This procedure will require constant coordination with all sections of the work.

1.8 STRUCTURAL DRAWINGS AND SPECIFICATIONS

- A. Each Contractor shall refer to the Structural Drawings and Specifications for the general construction of the building, for floor and ceiling heights, for location of walls, partitions, beams, grade beams, foundations, footings etc., and shall be guided accordingly for the setting of all sleeves and equipment.
- B. Under no circumstances shall a Contractor scale the Drawings for the locations of equipment and work.
- C. The contractor is responsible for reviewing all below slab / underground piping with structural components and coordinating all stepped footings or sleeves where required.

1.9 CAPACITIES, SIZES AND OPERATING CONDITIONS

- A. Capacities, sizes, and conditions specified or shown on drawings shall be regarded as minimum allowable. If the Contractor proposes to furnish any equipment which would have to operate at other than specified conditions to produce final effects, all other directly or indirectly related components of the entire systems (as well as of the structure, finish, and other systems in the building) must be properly coordinated to the satisfaction of the Engineer. That is: Operating conditions through the entire system must be such that no motor is overloaded, no equipment operates noisier, faster, or hotter than manufacturer's publication recommends and that no excess stress or demand is imposed on any component of any system or the structure; also, that no quality, architectural feature, function or "end result" is affected adversely, in the opinion of the Architect.
- B. The Architect/Engineer reserves the right to determine if the Contractor's proposed materials and equipment of any one manufacturer is acceptable in lieu of the specified material or equipment.
- C. Where materials and equipment are listed on Drawings and specifications as acceptable or equivalent, this does not relieve the Contractor and/or manufacturer from providing and proving to Architect/Engineer that their materials and equipment are equivalent to items the Architect/Engineer used as a guide specification.

- D. The Contractor and manufacturer must confirm to the Architect/Engineer that their equipment and materials will meet the space requirements of the project and that the equipment is easily accessible for maintenance and operation.

1.10 ACCESSIBILITY

- A. All equipment, valves, motors, damper operators, traps, unions, and all other items which require adjustment, maintenance, repair, and observation shall be installed in such a fashion that such maintenance, repair, and observation can be readily achieved without undue difficulty. Where the drawings show these items in locations not conforming to the above, the Contractor shall advise the Architect/Engineer of this conflict prior to bid Date otherwise he shall, at his own expense, relocate such items as directed by the Architect/Engineer. Where such items are installed above inaccessible ceilings or in or behind walls, this Contractor shall provide approved access panels unless otherwise directed in these Specifications.

1.11 SUBMITTALS

- A. Review of Materials and Equipment: Within 30 days of receipt of notice to proceed, and before starting installation, the Contractor shall submit to the Architect for review, electronically (PDF format), lists of materials, fixtures, and equipment to be incorporated in the work. If departures from the contract drawings are deemed necessary by the Contractor, details of such departures, including changes in related portions of the project and the reasons therefore shall be submitted with drawings. Where such departures require piping or equipment to be supported otherwise than shown, the details submitted shall include loadings and type and kinds of frames, brackets, stanchions, or other supports necessary. Any departures shall be made at no additional cost to the Owner. The lists of materials and equipment shall be supported by sufficient descriptive material, such as catalog cuts, diagrams, and other data published by the manufacturer, as well as evidence of compliance with safety and performance standards, to demonstrate conformance to the specification requirements; catalog numbers alone will not be acceptable.
- B. Conformance to Agency Requirements: Where materials or equipment are specified to be constructed and/or tested in accordance with the standards of the American Society of Mechanical Engineers, the Air Moving and Conditioning Association, or the American Society of Heating, Refrigerating and Air Conditioning Engineers, or to be approved by the Underwriters' Laboratories, Inc., the Contractor shall submit proof that the items furnished under this specification conform to such requirements. A certificate or published statement by the manufacturer will be sufficient evidence that the item conforms to the specified requirements. In lieu of such stamp, certificate, or statement, the Contractor may submit written certificate from any nationally recognized testing agency adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the requirements listed hereinbefore, including methods of testing, of the specified agencies.
- C. Shop Drawings
 - 1. The review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the Contract Documents. In all cases, the Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, all applicable codes and regulation are met, all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.
 - 2. In accordance with the General Conditions, shop drawings shall be submitted on all units of prefabricated materials. Shop drawings shall show, in detail, all parts of the work, fully dimensioned and shall also indicate construction, concealed and other jointing, thickness of materials, method of anchoring and attachment to

other materials. Where required for certain work, submit setting and bending diagrams and mark same to correspond with the design drawings, identifying locations of various items. Show types, sizes and locations of sleeves and inserts.

3. Each shop drawing and/or manufacturers descriptive literature shall have the proper notation indicated with all accessories and features and shall be clearly referenced to the specifications and equipment schedules.
4. Both the Contractor and Prime Contractor shall check all shop drawings for completeness and for correctness before submitting the drawings to the Engineer. If major corrections are required on the drawings, the Contractor shall return the drawings to the originator and have the changes made. The Contractor shall indicate his corrections on the prints in green pencil and sign all prints and other material sent to the Engineer.
5. The Mechanical Contractor shall be responsible for final coordination of all electrical requirements (voltage, phase, circuit breaker sizes, wire sizing, etc.) with the Electrical Contractor prior to ordering any equipment or materials. There will be no change in the Contract Amount for any discrepancies.
6. Detail and Erection Drawings: Detail and erection drawings for equipment, piping and other items of this nature shall be carefully prepared in accord with standard practice and shall show erection plans and member details with all individual parts identified on both the detail sheets and erection plans. All identification markings shall be carefully preserved until after the erection process is completed.
7. Material Data: The Contractor shall submit descriptive data, as required, on pipe, fittings, and valves to be incorporated into the work. This data shall be in sufficient detail to allow the Engineer to determine that the pipe, fittings, and valves meet the requirements of the contract drawings and specifications or that they are an acceptable equal to that specified. All data shall be in the form of manufacturer's or supplier's literature concerning the product and shall indicate catalog number, conditions of use, application instructions, and/or other information as applicable.
8. Equipment Data: The Contractor shall submit descriptive data on all items of equipment to be furnished and installed under this contract. These submittals shall consist of manufacturer's published catalog information which completely describes component materials, configuration and rough-in data for mechanical and electrical equipment shall also include cuts, diagrams, characteristic curves, and capacity information as applicable. Where more than one item of equipment is employed in the same system, the submittal of equipment data will include special diagrams showing the electrical wiring, interconnecting piping, related controls and relation and operation of the various items of equipment for the entire system.

D. Materials, Equipment and Appliances

1. Materials: All materials, equipment, products, and incidentals to be furnished by the Contractor shall be new, unless otherwise specified, undamaged and the first line quality product of the manufacturer and/or supplier, except when competitive grades fully meet the standards specified in the various technical sections of these specifications.
2. Standard Products: Except as otherwise approved by the Engineer, the equipment, and appliances to be furnished under these specifications shall be the standard products of manufacturers regularly engaged in the production of such equipment and shall be the manufacturer's latest standard design. Where

two or more units of the same type and class of equipment are required, the units shall be the product of the same manufacturer and shall be identical insofar as possible. The component parts of the products need not be products of one manufacturer.

3. **Manufacturer's Directions:** Where manufacturer's instructions or recommendations are applicable to the installation or application of materials, the Contractor shall adhere to strict conformance with such instructions or recommendations unless specifically noted to the contrary in these specifications. Where such directions are in conflict with the drawings and specifications, the Contractor shall inform the Engineer of such conflict and request instructions.
4. **Samples:** The Contractor shall furnish, for approval, samples of materials, profiles, designs, finishes, etc., which are either required by the various sections of specifications or which the Engineer may request from time to time. Samples shall be clearly identified with adequate information for the Engineer's evaluation.
5. **Materials and Equipment Delivered to Jobsite:** All items of materials, equipment, supplies and miscellaneous items to be incorporated into the work shall be delivered to the jobsite with labels, tags, nameplates and/or containers which clearly indicate the manufacturer's item or catalog number or conformance with the applicable standards stipulated in the technical sections of the specifications. Any item which cannot be verified in the field shall not be included in the work until its identity can be established by the Engineer.

E. **Equipment and Material Substitutions**

1. Should the Contractor elect to use and install materials which have been approved for use other than specified, he shall be required to make any necessary changes, perform all work, and furnish any additional materials and ancillary equipment required to make such substituted materials or equipment function or perform as that specified, at no cost to the Owner. This includes structural, electrical and/or other affected trades.

1.12 **PROTECTION OF EQUIPMENT AND MATERIALS**

- A. No piping shall be installed in any part of the building where danger of freezing may exist without adequate protection being given, whether or not insulation is specified for the particular piping. All damage resulting from leaking pipes shall be borne by the Contractor under this Division. Do not install piping across or near openings to the outside whether or not they are carrying static or moving fluids. Insulation on piping does not ensure that freezing will not occur. The Contractor shall contact the Engineer when in doubt.
- B. All work, equipment and materials shall be protected at all times. All pipe and ductwork openings shall be closed with caps or plugs during construction. All equipment and accessories shall be tightly covered and protected against dirt, water, or other injury during the period of construction.
- C. If the permanent HVAC equipment is used during the construction period for temporary heating, cooling, and ventilating, the equipment must be carefully protected, and filters changes at minimum of once a week. All return air and exhaust air ductwork used in temporary HVAC systems during construction period must be filtered at each opening to prevent construction dust from entering the ductwork system. Use of any permanent systems does not alter or prematurely begin the warranty period.

1.13 **EXAMINATION OF SITE**

- A. Bidders shall visit the site before submitting proposals to satisfy themselves as to the nature and scope of the work and any difficulties attending to the execution.

- B. The submission of a proposal will be construed as evidence that such an examination has been made. Later claims for labor, equipment, materials, etc., required for difficulties encountered which could have been foreseen had such an examination been made, will not be recognized.

1.14 EXISTING CONDITIONS

- A. The locations of all piping, conduits, cables, utilities, and manholes existing, or otherwise, that comes within the contract construction site, shall be subject to continuous uninterrupted service with no other exception than the Owner of the utilities permission to interrupt same temporarily. Provide a seven (7) day written notice to Engineer, Architect and Owner prior to interrupting any utility service or line.
- B. Known utilities and lines as available to the Engineer are shown on the Plans. However, it is additionally required that, prior to any excavation being performed, each Contractor ascertains and marks all utilities or lines that would be endangered by the excavation. Hand dig if required to locate. Contractor shall bear costs of repairing damaged utilities.
- C. If utilities or lines occur in the earth within the construction site, the Contractor shall probe and locate the lines prior to machine excavation in the respective area. Hand dig if required to locate.
- D. Cutting into existing utilities and services shall be performed in coordination with and as designated by the Owner of the utility. The Contractor shall work continuously to restore service(s) upon deliberate or accidental interruption, providing premium time and materials as needed without extra claim to the Owner.
- E. The Contractor shall repair to the satisfaction of the Owner and Engineer any surfaces or subsurface improvements damaged during the course of the work, unless such improvement is shown to be abandoned or removed.
- F. Machine excavation shall not be permitted with ten feet of gas lines, fuel lines, electrical lines or lines carrying combustible and/or explosive materials. Hand excavate only in accord with utility company, agency or other applicable laws, standards, or regulations.
- G. Protect all new or existing lines from damage by traffic, etc. during construction. Repair or replacement of such damage shall be at the sole expense of the party responsible.
- H. Protect existing trees, indicated to remain with fencing or other approved method. Hold all new subsurface lines outside the drip line of trees, offsetting as necessary to protect root structures. Refer to planting or landscaping plans, or in their absence, consult with the Architect.

1.15 DEMOLITION AND SCHEDULE

- A. All existing mechanical equipment noted on drawings and listed herein that is to be removed or demolished, shall be removed on schedule, and disposed of as hereinafter directed.
- B. All items removed shall become the property of the Contractor and shall be immediately disposed of off-site at Contractor's expense except as noted on drawings unless otherwise directed by owner.
- C. All demolition shall be carefully accomplished in accordance with the master construction schedule so as not to remove any item required for support operation during the planned schedule. No item shall be removed until full schedule is worked out with Contractors according to owner's demands and agreed to in writing by the Engineer.
- D. Storage will be arranged during the scheduling process. Contractors to provide their own storage and security.
- E. Contractor performing the demolition of equipment must conform to the Clean Air Act of 1990. Refrigerant must be recovered from any air conditioning or refrigeration equipment

prior to disconnecting and disposal. The Contractor must own and use recovery equipment to meet this requirement. The Contractor shall be responsible for the disposal of refrigerant, refrigerant oil, or equipment.

- F. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damage or unserviceable portion and replace with new products of equal capacity and quality. All existing piping to remain shall be permanently capped, new or existing valves are not adequate.

1.16 CUTTING AND PATCHING

- A. All cutting and patching required in connection with the installation of this work, and work due to errors, defective work, ill-timed work, or tardiness in properly designating size and location in sufficient time or by failure to notify other trades, shall be done under this section, but only in the manner directed by the Engineer so as to prevent or minimize damage to installed work. Damage as a result of cutting for installation, shall be repaired by mechanics skilled in the trade involved, at no additional expense to the Owner.
- B. No cutting of structural members will be permitted, except when prior permission of the Engineer has been obtained. This work must conform in every respect to the surrounding finish and to the quality of workmanship and materials used.
- C. Piercing of any waterproofing or roofing shall be done only by the trade involved. After the part piercing the waterproofing has been set in place, the opening made for this purpose shall be filled and made absolutely watertight to the satisfaction of the Engineer.
- D. See Section: 230517 - SLEEVING, CUTTING, PATCHING AND REPAIRING - MECHANICAL

1.17 FIRE AND SMOKE-STOPPING

- A. Fire-stopping and smoke-stopping shall be provided around all piping and ductwork penetrations of fire rated and/or smoke-rated floors, walls, ceilings, or other barriers.
- B. The materials used shall be UL 263 or UL 1479 classified and meet ASTM E814 standards and be rated for assemblies where applied.
- C. Clean surfaces to be in contact with penetration seal materials, of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.
- D. Install penetration seal materials in accordance with manufacturer's instruction.
- E. Seal holes or voids may be penetrations to ensure an effective fire and/or smoke barrier.
- F. Protect materials from damage on surfaces subject to traffic.
- G. Stop insulation flush with wall on insulated pipe and seal edges.
- H. All exposed piping passing through floors, ceilings and walls in finished areas shall be fitted with a chrome plated escutcheon of sufficient outside diameter to amply cover the sleeved opening and ad inside diameter to closely fit the pipe around which it is installed.
- I. Galvanized sheet metal collars shall be provided around all ducts, equipment, etc., exposed in finished areas. Where such openings are finished and the space around the unit is small, the collar may be omitted with the approval of the Architect.

1.18 CONCRETE WORK AND ANCHOR BOLTS

- A. The Contractor under this Division shall provide all concrete bases, curbs and pads for all floor and ground mounted equipment unless otherwise indicated.
- B. The Contractor under this Division shall verify the sizes and locations of all supports, bases, and pads prior to pouring of same to be certain that the installed units will be compatible.

- C. The Contractor under this Division shall set anchor bolts when required for the equipment prior to pouring concrete. Sizes and exact locations of bolts shall be determined by the manufacturer's recommendations for the equipment served.
- D. Concrete work must be provided in strict accordance with Section 03 Concrete Work. As a minimum provide pads using 3500 psi concrete not less than 3.5 inches high reinforced with W1.4 x W1.4 welded wire fabric. Chamfer top and edge corners with 3/4" preformed chamfer strips. Subbases shall rest on structural floor and shall be reinforced with steel rods and interconnected with floor reinforcing bars by tie bars hooked at both ends or suitable dowels. Slope top to floor drain if drain is provided in pad.

1.19 ELECTRIC MOTORS

- A. All motors shall be designed, tested, and applied in accordance with the applicable standards listed hereinbefore. Motors shall be of sufficient size for the duty to be performed and shall not exceed the full load rating when the driven equipment is operating at specified capacity. Unless otherwise specified, all motors shall be high efficiency type and shall have open frames and continuous-duty classification based on 50 degrees C. ambient temperature. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics. Motors shall meet NEMA high efficiency standards MGI - 1.41.2 for energy efficient polyphase squirrel-cage motor. Efficiency shall be in accordance with MGI - 1.2.55. When motor horse powers required differ from those indicated on the drawings, the Contractor shall make the necessary adjustments to the wiring, disconnect devices, starters, and branch-circuit protection at no additional cost to the Owner.
 - 1. Motors shall be rated for continuous duty capable of driving the connected loads without exceeding temperature limitations of the motor insulation. Special Class A moisture-resisting insulation (designed to operate in a 122-degree F. ambient without exceeding a temperature rise rating designated by NEMA for the type of enclosure used) shall be utilized in each motor.
- B. Unless otherwise indicated or specified, the electrical components required to operate mechanical equipment, such as, motors, float and pressure switches, solenoid valves, and other devices functioning to control the mechanical equipment, shall be furnished as part of the mechanical equipment, shall be complete and operable, and shall be included under this section of the specifications. All motor starters not part of a motor control center shall be included under this Section and shall be the hand off auto type with 3 over-loads on 3 phase units and 120V control transformer. Conduit and wires required for external electrical connections shall be furnished and are specified under DIVISION 26 - ELECTRICAL. Integral phase failure relay shall be provided as a part of all three phase motor starters. Relay shall shut motor down on phase loss or phase unbalance and automatically reset when normal phasing is restored. Phase failure relay shall have adjustable restart time capabilities. Mechanical Contractor shall coordinate staggered restart times as required.

1.20 DRIVES

- A. Each belt-connected motor-driven unit or fan shall be provided with a variable pitch V-belt drive.
- B. Sheaves shall be of cast iron or of steel, statically and dynamically balanced, bored to fit properly on the shafts and secured with key of proper size. Sheaves having set screws alone will not be permitted. Sheaves shall be variable pitched and shall be designed to give the required rpm at approximately the mid-position of adjustment. Pitch diameters of sheaves shall be not less than 3.0 inches for "A" section belts; 5.4 inches for "B" section belts; 9.0 inches for "C" section belts; and 13.0 inches for "D" section belts.
- C. Belts shall be selected for a minimum service factor of 1.5 (based on motor nameplate horsepower) and selected and matched in sets for equal tension.

- D. All other drives shall be as described under the respective equipment paragraph of these Specifications, as applicable.

1.21 ACCESS PANELS

- A. The Mechanical Contractor shall furnish all other access panels needed for access to valves, open receptacles, vents, fire dampers, mechanical units, etc., in inaccessible locations installed under this Division of the work.
- B. Access panels shall have a minimum size of 12" x 12" and shall be centered beneath equipment for accessibility and maintenance. Access panels must be of adequate size to service, observe, remove, and maintain equipment.
- C. Access panels shall be equal to the types specified under the Architectural Specifications. As a minimum the access panels shall be equivalent to Acudor Products, Cendrex, Inc., MIFAB, Inc., Lane-Aire Manufacturing, 14 gauge with vandal proof lock and frame as selected by Architect. Access panels shall be fire rated when installed in fire rated construction.
- D. Access panels shall have a primed white finish.
- E. Ceiling Types
 - 1. In areas with suspended acoustical tile ceilings (installed on exposed metal grid suspension system so that the tile may be readily removed), equipment, valves, etc., installed above these ceilings will be considered accessible.
 - 2. All plastered ceilings or ceilings having concealed spline type of suspension system will be considered as not removable for accessibility to equipment; therefore, access panels will be required.
 - 3. See Architectural Drawings and Specifications for the types of ceilings throughout the building.
- F. Access panels shall be installed by sub-Contractor specialized in access panel installation.

1.22 CONNECTION TO EQUIPMENT SPECIFIED IN OTHER SECTIONS

- A. Examine all Contract Documents and be thoroughly familiar with all items of equipment in other sections or by Owner, unless otherwise specified or indicated on Drawings. Rough-in for and make final connections to all equipment which requires any of the services specified in this Section and including furnishing and install all valves, P-traps, unions, vacuum breakers, and all other specialties as required to make all work and equipment final and operating. It is the intent of the Contract Drawings to detail and indicate all such equipment; however, be responsible for notifying Architect/Engineer in writing of major discrepancies seven (7) days prior to Bid Date; otherwise, all such connections shall be made at no extra cost. The Contractor shall finally connect mechanical services (water, sanitary, gas, air, etc.), to any terminal equipment, appliances, kitchen equipment, etc., provided under this and/or other divisions of the work. Various equipment connections indicated are based upon "basis of design" equipment selections. Should alternate equipment be purchased, then this Contractor shall make the necessary provisions in the Bid for any and all differences. Change Orders shall not be considered for any differences due to alternate equipment purchase. Such connections shall be made in strict accord with current codes, safety regulations and the equipment manufacturer's recommendations. If in doubt, contact the Engineer prior to installation.
- B. Unless specified otherwise, all conduit, wiring and connections for power to mechanical equipment will be provided by Electrical Contractor. The Mechanical Contractor shall be responsible for correcting sequences of operation of all mechanical equipment after all wiring has been completed.

1.23 SAFETY

- A. The Contractor and his Sub-Contractors for the project shall comply with all applicable Federal, State, and local laws governing safeguards, safety devices, and protective equipment and shall take all other needed actions which they may determine or which the Department may determine to be reasonably necessary to protect the life and health of all employees and personnel on the project, provide for the safety of the public and protect all property affected by the performance of the work covered by the contract.
- B. As provided in KRS Chapter 338 in the Kentucky Occupational Safety and Health Act and in subsequent regulations and standards promulgated by the Kentucky Occupational Safety and Health Standards Board, neither the Contractor nor his Sub-Contractors shall require any laborer or mechanic employed in performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health and safety.
- C. The Contractor shall not remove or disturb any suspected hazardous materials, including asbestos-containing materials, lead-based paints, electrical equipment containing PCBs, or any other except as instructed in this contract. If any material not covered by the contract is encountered, notify the Engineer immediately.
- D. All belts, pulleys, chains, gears, couplings, projecting setscrews, keys and other rotating parts located so that any person can come in close proximity thereto shall be fully enclosed or properly guarded.

1.24 OPERATING INSTRUCTIONS / START-UP

- A. After all tests have been completed and work accepted by the Owner, a competent representative shall, at a time determined by the Engineer, present verbal, and visual instructions to the Owner's personnel in the proper operation of his respective system. For this purpose, each section of work shall be demonstrated and explained to the Owner's personnel and sufficient time allotted for instructions.
- B. The Contractor shall include in their bid to provide equipment and controls startup and verification for all mechanical systems specified for this project.
- C. A pre-start-up conference shall be held with the Architect, Engineer, Owner, General Contractor, Mechanical Contractor, Electrical Contractor, Controls Contractor, Test and Balance Contractor, Commissioning Agent (where applicable), and the Manufacturer's providing startup services. The purpose of this meeting will be to discuss the goals, procedures, etc. for start-up.
- D. Specific startup/verification specifications are included throughout the Mechanical Specifications. In general, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians, not third-party Contractors, and shall complete and submit start-up reports/checklists. The Contractor shall have appropriate trades on site to correct all deficiencies noted by the factory representative. For each deficiency noted, documentation of corrective action (including date and time) shall be submitted to the Engineer and Owner. Where factory start-up is not specified for a particular piece of equipment or system, the Contractor shall be responsible for performing start-up. All information shall be completed by the Contractor and submitted to the Owner/Engineer prior to acceptance of the equipment.
- E. The Contractor shall be responsible for completion of System Verification Checklists/Manufacturer's Checklists. Factory startup is required for all HVAC equipment noted. Unless noted otherwise, as part of the verification process, equipment suppliers shall perform start-up by their factory authorized technicians and shall complete and submit start-up reports/checklists. This shall include the following:
 - 1. Rooftop Units
 - 2. VAV Boxes

3. Variable Frequency Drives
 4. Exhaust Fans
 5. Temperature Controls
- F. Except for the specific equipment specified in this Specification Section, the manufacturer's recommended startup procedures and checklists will be acceptable for use in the project. Where "manufacturer" startup is not specified, then this Contractor shall perform startup services in strict accordance with manufacturer's instructions. All startup/verification process shall be thoroughly documented by the Contractor and shall include the time and date when performed.
- G. The Contractor shall "zip-tie" a start-up report to each piece of equipment in a clear plastic cover. Once start-up completion is verified by the Engineer the Contractor shall remove all reports and consolidate them into close-out documentation. The Contractor shall be responsible for completion of System Verification Checklist (SVC) / Manufacturer's Checklists.

1.25 TESTS

- A. All tests required to establish the adequacy, quality, safety, completed status and suitable operation of each system and all components thereof shall be made in the presence of and to the satisfaction of the Engineer or his authorized representative and other representatives of State and local Government. All instruments, labor, and expert service necessary to conduct these tests shall be supplied by the Contractor; power and fuel will be furnished by the Owner.
- B. The final inspection and tests are to be made only after the Engineer is satisfied that the work described in these specifications has been completely installed in accordance with the true spirit and intent of these specifications and that complete preliminary tests were made which indicate adequacy, quality, completion, and satisfactory operation. The acceptance of the work herein specified shall not in any way prejudice the Owner's right to demand replacement of defective material and/or workmanship.
- C. The Architect/Engineer shall be notified by the Contractor under this Division forty-eight (48) hours in advance of any tests so that the Architect/Engineer or his representative may be present when the tests are run. Leaks or imperfections found shall be corrected and a new test shall be run to the satisfaction of the Architect/Engineer. Upon successful completion of the test, pipe covering may be applied, and piping may be concealed. A successful test, even if witnessed, however, does not relieve the Contractor under this Division of the responsibility for any failure during the guarantee period.
- D. After pipe fabrication has been completed, all water piping shall be subjected to a hydrostatic test of 100 psi and proven tight and free of leaks for a 24-hour period. Tests shall be applied to the piping before being attached to any equipment which would be damaged by the test pressure. Damage to equipment caused by testing shall be repaired or replaced without additional cost to the Owner.
- E. Exterior water piping shall be tested in strict compliance with local water company. The minimum hydrostatic test pressure is 1 1/2 times the water pressure serving the site.
- F. No insulation, paint, backfill or other prohibitive covering shall be applied to piping prior to the above tests.
- G. Provide all temporary equipment, materials, valves, gauges, etc., required for the preceding tests.
- H. The expense of all tests shall be borne by the Contractor under this Division.
- I. In addition to the testing specified above the Contractor shall perform the following HVAC systems tests and place the system(s) in operation to demonstrate that all features of the

system(s) including instrumentation, controls, and equipment function as specified for final acceptance.

1. At such time as the Engineer determines that the new heating, ventilating, and cooling system is ready to be placed into service, the Contractor shall place the new equipment in operation and demonstrate that the safety devices are in proper working order to the satisfaction of the Engineer.
2. The Contractor shall then maintain operation and demonstrate each system's capability of producing at full load capacity. Within 24 hours after the systems have been satisfactorily tested, Owner operating personnel will relieve the Contractor of the operations and the Contractor shall continue his work on a joint occupation basis.
3. Depending on the status of the work, the Contractor may at his option conduct other required tests concurrent with, prior to, or following the system testing, providing the Engineer is satisfied the installation is in conformance with the specifications. However, all features of the system(s) shall be tested individually for proper operation at partial and full load conditions and collectively where normal operations require the several components to operate concurrently to constitute an acceptable system.
4. Final acceptance of the entire installation will be based on an acceptable demonstration that all components, local and remote, respond to safety manual and Automatic System controls. During this test, the Contractor shall cause simulated perturbations for which the control system is designed to respond. All control, monitor and readout points in the system shall function properly before final acceptance is made.

1.26 CLEANING

- A. Before the building is turned over to the Owner, all of the piping, ductwork and equipment must be carefully cleaned of debris and dust. All coils shall be cleaned and flushed out with new filters installed.
- B. Utilities and Equipment: The Contractor shall provide all necessary temporary materials and equipment to clean the piping and equipment installed under this specification. No permanent equipment shall be used for storage, mixing, settling, compressing, pumping, etc., without the approval of the Architect. The Contractor shall supply a separate and independent source of clean, dry, oil-free air for the blowdown of systems requiring this method of cleaning.
- C. Use of Chemicals: No chemicals, wetting or drying agents shall be used to clean systems or equipment where the materials of the system undergo any changes in their physical or structural characteristics. In case of any doubt as to the compatibility of any materials to the cleaning solution used, the Contractor shall obtain prior written approval for the use of the solution from the manufacturer of the equipment. Piping systems, equipment and sub-assemblies shall be cleaned after completion of welding, machining, threading, testing and any other operations capable of contaminating the system piping or equipment. After cleaning, the permanent strainers shall be removed, cleaned, and replaced. Temporary strainers shall be periodically removed, cleaned, and replaced during cleaning in lines ahead of equipment to protect against particles becoming lodged in the equipment.
- D. After the Architect/Engineer has completed the examination, this Contractor shall remove all stickers, tags, etc., and shall thoroughly clean all equipment, fixtures, and materials installed under his section of the work.
- E. Surplus material, rubbish and equipment resulting from the work shall be removed from the building and premises by the Contractor upon completion of the work in accordance with the General Conditions.

- F. All equipment shall be thoroughly cleaned to "Factory New" condition prior to turning over to Owner. Touch up or completely re-paint equipment as required.
- G. Keep all nameplates on equipment clean and exposed for easy reading.

1.27 PUNCH LISTS

- A. The Contractor shall prepare and complete punch lists for all their scope of work and all associated Sub-Contractors.
- B. The Engineer shall be notified one week in advance of above ceiling and below ceiling / final inspections.
- C. Upon completion of all punch list items, the Contractor shall request that the Engineer develop a punch list. After all corrections have been made from the Engineer's punch list, the Contractor shall review and initial off on each item. This signed-off punch list shall be submitted to the Engineer. The Engineer shall return to the site only once to review each punch list and all work prior to the ceilings being installed and at the final punch list review. The Contractor's representative may be requested at the inspections.
- D. Upon inspection by the Engineer, if there are discrepancies found indicating the punch list is incomplete and additional visits will be required by the Engineer to review the incomplete work, the Engineer shall be reimbursed directly by the Contractor. This payment shall be made by check or money order to STW and due 10 days from date of each additional visit at a rate of \$125.00 per hour plus travel expense for any extra trips required to complete either/any of the above ceiling, below ceiling or final punch lists. Sign-off on project completion will not be granted by the Engineer until all punch list items are deemed corrected at the Engineer's discretion and any additional monies due have been received by the STW.

1.28 WARRANTY AND SERVICE

- A. All equipment and labor shall be warranted for a period of at least one (1) year from the date of acceptance, as evidenced by date of substantial completion for the entire project or for the last phase of the project, whichever occurs later, against defective materials, design, and workmanship. In addition to the equipment warranty, the Contractor shall provide all repair and adjustment service necessary for the proper operation of the entire system for a period of one (1) year after the date of acceptance, as evidenced by the date of substantial completion for the entire project or for the last phase of the project, whichever occurs later. Upon receipt of notice from the Owner's representative of failure of any part of the warranted system or equipment during the warranty period, the affected part shall be replaced promptly with a new part without cost to the Owner. Upon failure to take action within 24 hours after being notified, the work will be accomplished by the Engineer at the expense of the Contractor. See General Conditions and individual equipment specifications. Note that the warranty period of time specified in this section represents the minimum warranty period required for work performed under specification Division 21, 22 and 23. Where the General Conditions and/or individual equipment/system specifications require a warranty period of longer duration or earlier start date than specified in this paragraph, the longer duration/earlier start date shall supersede for those portions of work covered by that specification. In the event the Contractor is notified of warranty issues but does not correct or address the warranty issues prior to the end of the specified warranty period, the Contractor will not be relieved of the responsibility to correct the deficient items after the warranty end date has passed.
- B. Make a minimum of two (2) service calls during guarantee period, free of charge, to check with Owner and to check and repair malfunctioning equipment which was installed. Service calls shall be in the middle and end of the guarantee period and as required to maintain the system's operation. Dates shall be listed in operating and maintenance manuals, along with Contractor's name and phone number.

- C. The use of any permanent systems prior to substantial completion or the time identified by the GC/CM (whichever is more strict), does not alter or prematurely begin the warranty period.
- D. The Contractor shall furnish three (3) copies of all Final Inspection Certificates obtained to the Engineer when work is complete. Final payment for work will be contingent upon compliance with this requirement.

1.29 AS-BUILT DRAWINGS, DESCRIPTIVE DATA AND O&M MANUALS

- A. During construction, the Contractor shall retain a set of blue line drawings on the site for recording all changes. These drawings shall be available for inspection by the Engineer.
- B. The Contractor shall deliver to the Engineer at the completion of the work, one (1) print of "As-Built" drawings, showing legibly and accurately, mechanical and piping systems with equipment locations shown as actually installed. Changes in original plans shall be neatly shown in red pencil. Each print shall be signed by the sub-Contractor who has done the work.
- C. Operating Instructions and Maintenance Manuals, Etc.
 - 1. At completion of the contract, the Owner shall be provided with three (3) bound copies of operations and maintenance instructions, recommended list of spare parts required for a period of one (1) year and a list of any special tools required to maintain the equipment for the various items of the mechanical equipment. Where special tools are required, the Contractor shall furnish two (2) of each such tools to the Owner at no additional contract cost.
 - 2. MANUAL SHALL INCLUDE ALL APPROVED SHOP DRAWINGS OF EQUIPMENT REQUIRING OPERATION AND MAINTENANCE INFORMATION.
 - 3. MANUAL SHALL BE ORGANIZED WITH APPROVED SHOP DRAWING FOLLOWED BY ALL RELATED OPERATION AND MAINTENANCE MATERIAL.
 - 4. EQUIPMENT SHALL BE IDENTIFIED IN ACCORDANCE WITH THE DRAWING NOMENCLATURE AND INCLUDE SUPPLIER OF SAID EQUIPMENT.
 - 5. Instructions shall be included for routine checking of all items requiring continued maintenance.
 - 6. Schematic drawings with actual pieces of mechanical equipment, etc., shall be included; where manufacturer's parts numbers only are applicable, they shall be included.
 - 7. Detailed operating instructions for mechanical equipment shall be included, as well as general maintenance procedures to be followed on such equipment. Manufacturers maintenance and operation manuals will be required where such are normally available with the equipment, but as such information is often of a general nature and applicable to various models of equipment, such information shall be supplemented by specified typed directions for the particular piece of equipment applicable to this project.

1.30 DIGITAL DATA AND FILE TRANSMISSION

- A. Sub-Contractors (SC) requiring digital files to prepare shop drawings and governmental agency submittals shall make their request through the Construction Manager (CM) or General Contractor (GC).
 - 1. The CM/GC shall compile a list of requested drawings from the respective SC's and submit one comprehensive list to STW.
 - 2. STW will provide the CM/GC with a digital file transmission release form. The CM/GC may sign and return or have the requesting SC's sign and return to STW through the CM/GC.

3. After receiving the signed release form, STW will provide one set of all requested digital files to the CM/GC to then distribute to the appropriate SC's.
 4. STW will provide AutoCAD/dwg files.
 - a. Revit/BIM models will not be provided to Contractors. Projects completed using REVIT will be exported to AutoCAD prior to releasing.
- B. The project architect is the owner/author of the floor plans and reflected ceiling plans.
1. The architect must approve the release of these plans before STW can release our respective drawings.
 2. Requests for floor plans and/or reflected ceiling plans only shall be made directly to the architect.

END OF SECTION 23 01 00

SECTION 23 05 17 – SLEEVING, CUTTING, PATCHING AND REPAIRING FOR MECHANICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes requirements for the Mechanical Contractor related to sleeving, cutting, patching, and repairing associated with mechanical work.

1.2 WORK INCLUDED

- A. Sleeves
- B. Sleeve Seals
- C. Grout
- D. Escutcheons
- E. Lintels

1.3 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 230100 - GENERAL PROVISIONS FOR MECHANICAL WORK

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 water stop 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. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness, round tube closed with longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Metraflex Company (The).
 - 3. 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 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, 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.

2.3 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 ESCUTCHEONS

- A. Escutcheons shall be Beaton and Caldwell; Carpenter and Patterson; Fee and Mason or approved equivalent. Chromium-plated iron or chromium-plated brass, either one piece or split patterns, held in place by internal spring tension or set screw that completely covers opening.

2.5 LINTELS

- A. New openings under 48" in width: Provide one 3 1/2" x 3 1/2" x 3 1/2" steel angle for each 4" of masonry width. Lintel shall have 8" bearing on either side.
- B. New openings 48" to 96" in width: Provide one 3 1/2" x 6" x 3/8" steel angle for each 4" of masonry width. Lintel shall have 8" bearing on either side.
- C. New openings over 96" in width: Consult the project structural engineer.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall be responsible for all openings, sleeves, trenches, etc., that he may require or create by demolition in floors, roofs, ceilings, walls, etc., and shall coordinate all such work with the General Contractor and all other trades. Coordinate with the General Contractor, any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the Contractor.
- B. The Contractor shall plan his work ahead and shall place sleeves, frames or forms through the walls, floors, and ceilings during the initial construction, where it is necessary for piping, ductwork, conduit, etc., to go throughout; however, when this is not done, the Contractor shall do all cutting and patching required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Engineer. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at his own expense.
- C. The Contractor shall notify other trades in due time where he will require openings or chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.
- D. The Contractor shall be responsible for properly shoring, bracing, supporting, etc., any existing and/or new construction to guard against cracking, settling, collapsing, displacing, or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements shall be promptly and properly made good to the satisfaction of the Engineer.

- E. All work improperly done or not done at all as required by the Mechanical Trades in this section, will be performed by the Contractor at the direction of the trade whose work is affected.

3.2 SLEEVES

- 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 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 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.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.
- F. Pipes Passing Through Waterproofing Membranes: Pipes passing through floor waterproofing membrane shall be installed through a 4-pound lead-flashing sleeve, or a 0.032-inch thick aluminum sleeve, each with an integral skirt or flange. Flashing sleeve shall be suitably formed, and the skirt of flange shall extend not less than 8 inches from the pipe and shall set over the floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 1 inch above the floor. The annular space between the flashing sleeve and the metal-jacket-covered insulation shall be sealed. At the Contractor's option, pipes passing through floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and a pressure ring with brass bolts. Waterproofing membrane shall be clamped into space and sealant shall be placed in the caulking recess.
- G. Pipes Passing Through Roof: Pipes passing through the roof shall be installed where shown on the drawings. Any penetration in roof shall be approved by the Roofing Manufacturer.
- H. Openings for ductwork, fixtures, equipment, etc. through floors, walls, ceiling, and roofs, shall be located and sized by the Contractor under this division who shall provide and set necessary lintels, sleeves, and sheet metal forms for all such openings.
- I. Galvanized sheet metal collars shall be provided around all ducts, equipment, etc., exposed in finished areas. Where such openings and finished and the space around the penetration is small, the collar may be omitted with the approval of the Architect/Engineer.

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 ESCUTCHEONS

- A. Escutcheons shall be provided at all finished surfaces where exposed piping, bare or insulated, passes through floors, walls, or ceilings. Escutcheons shall be fastened securely to pipe sleeves or to extensions of sleeves without any part of sleeves being visible. Where sleeves project slightly from floors, special deep-type escutcheons shall be used.

3.5 CUTTING

- A. All rectangular or special shaped openings in plaster, stucco, or similar materials, including gypsum board, shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirement is to provide smooth even termination of wall, floor, and ceiling finishes as well as to provide a fastening means for grilles, diffusers, lighting fixtures, etc.
- B. All trades shall coordinate all openings in masonry walls with the General Contractor, and, unless otherwise indicated on the Architectural drawings, shall provide lintels for all openings required for the plumbing work (piping, wall boxes, etc.).
- C. No cutting is to be done at points or in a manner that will weaken the structure and unnecessary cutting must be avoided. If in doubt, contact the engineer.
- D. Pipe openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.
- E. Openings in metal building walls shall be made in strict accord with building suppliers recommendations.

3.6 PATCHING AND REPAIRING

- A. Patching and repairing made necessary by work performed under this division shall be included as part of the work and shall be done by skilled mechanics of the trade or trades for work cut or damaged, in strict accordance with the provisions herein before specified for work of like type to match adjacent surfaces and in a manner acceptable to the engineer.
- B. Where portions of existing lawns, shrubs, paving, etc. are disturbed for installation or work of this Division, such items shall be repaired and/or replaced to the satisfaction of the engineer.
- C. Where the installation or removal of piping, etc. requires or creates the penetration of fire or smoke rated walls, ceilings or floors, the space around such pipe, etc., shall be tightly filled with an approved non-combustible fire insulating material satisfactory to maintain the rating integrity of the wall, floor or ceilings affected.
- D. Piping passing through floors, ceilings, and walls in finished areas, unless otherwise specified, shall be fitted with chrome plated brass escutcheons of sufficient outside diameter to amply cover the sleeved openings and an inside diameter to closely fit the pipe around which it is installed.
- E. Where pipes pass through exterior walls, the wall openings shall be sealed air and watertight. This shall include sealing on both sides of the wall to ensure air and water

does not enter or exit the wall cavity. This is especially critical on exterior walls where the wall cavity may be vented to the exterior.

END OF SECTION 23 05 17

SECTION 23 05 29 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Pipe and Equipment Hangers, Supports, and Associated Anchors

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 230100 - GENERAL PROVISION FOR MECHANICAL WORK
- C. Section 230719 - HVAC PIPING INSULATION
- D. Section 232113 - HYDRONIC PIPING AND VALVES

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product.
 - 2. Show fabrication and installation details.

1.4 REFERENCES

- A. ANSI/ASME B31.1 - Power Piping

1.5 SCOPE

- A. This specification shall apply for the design and fabrication of all hangers, supports, anchors and guides. Where piping design is such that exceptions to this specification are necessary, the system shall be identified, and the exceptions approved by Engineer prior to installation.

1.6 STRUCTURE

- A. This section is intended to cover the structural requirements of the piping and equipment. It is not intended to imply that the building structure will support the loads imposed. The contractor shall review the structural drawings for where loads can be applied, what load can be supported and what structural reinforcing is required. Specific questions can be directed to the structural engineer prior to bidding.

1.7 DESIGN

- A. All supports and parts shall conform to the latest requirements of the ANSI Code for Pressure Piping B31.1.0, and MSS Standard Practice SP-58, SP-69 and SP-89 except as supplemented or modified by the requirements of this specification.
- B. Designs generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized wherever possible.
- C. Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.
- D. Pipe hangers shall be capable of supporting the pipe in all conditions of operation. They shall allow free expansion and contraction of the piping, and prevent excessive stress resulting from transferred weight being induced into the pipe or connected equipment.
- E. Where possible, steel structural attachments shall be beam clamps. Other attachments shall be as scheduled.

- F. All rigid hangers shall provide a means of vertical adjustment after erection.
- G. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated, suitable support shall be provided to eliminate swing and allow for expansion.
- H. Where horizontal piping movements are greater than ½ inch, or where the hanger load angularity from the vertical is greater than 4 degrees from the cold to hot position of the pipe, the hanger rod to structural attachment shall be by use of Anvil Fig. 47 and Fig. 299 or the hanger rod and structural attachments shall be offset in such manner that the rod is vertical in the hot position.
- I. Contractor to fabricate and provide additional structural support as required to prevent sway where hanger rod lengths exceed 48" in length.
- J. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.
- K. All piping and equipment shall be braced and secured to prevent sway and movement in all axes.
- L. Hangers shall be spaced in accordance with ANSI B31.1.0
- M. Where practical, riser piping shall be supported independently of the connected horizontal piping.
 - 1. Pipe support attachments to the riser piping shall be riser clamp lugs. Welded attachments shall be of material comparable to that of the pipe and designed in accordance with ANSI B31.1 codes.
- N. Supports, guides and anchors shall be so designed that excessive heat will not be transmitted to the building steel. The temperature of support parts shall be based on a temperature gradient of 100 degrees F per inch distance from the outside surface of the pipe.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Anvil, Elcen, Mason Industries, Advanced Thermal, Fee & Mason, Piping Specialties, MIRO Industries.

2.2 SHIELDS

- A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi 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 beyond sheet metal shield for piping operating below ambient air temperature.
- F. Shields for Copper Pipe shall utilize sheet lead.

2.3 INSERTS

- A. Inserts: Malleable iron case or galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 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: Pre-galvanized, hot dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder coated.
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. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel.

2.5 TRAPEZE PIPE HANGERS

- ### A.
- Description: MSS SP-58, 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.

2.6 METAL FRAMING SYSTEMS

A. 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 factory-fabricated components for field assembly.
3. Channels: Continuous slotted carbon-steel channel within turned lips.
4. Channel Width: Selected for applicable load criteria.
5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel.
7. Metallic Coating: Pre-galvanized G90 (Z275).

2.7 BEAM CLAMPS

1. Beam clamps shall have malleable iron jaws, steel bolt or tie rod, nuts, and jamb nuts.
2. C-clamps will not be permitted unless retainer is provided.

2.8 PIPE STANDS

- ### A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support above grade, floor, and roof (without roof penetration).

B. Compact Pipe Stand:

1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe.

2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 3. Hardware: Galvanized steel or polycarbonate.
 4. Accessories: Protection pads.
- C. Low-Profile, Single Base, Single-Pipe Stand:
1. Description: Single base with vertical and horizontal members, and pipe support.
 2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
 3. Members: Two, galvanized-steel, continuous-thread 1/2-inch rods.
 4. Horizontal Member: Adjustable horizontal, galvanized-steel pipe support channels.
 5. Pipe Supports: Roller.
 6. Hardware: Galvanized steel.
 7. Accessories: Protection pads.
 8. Height: 12 inches above grade, floor, or roof.
- D. High-Profile, Single Base, Single-Pipe Stand:
1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 2. Base: Single vulcanized rubber or molded polypropylene.
 3. Vertical Members: Two, galvanized-steel, continuous-thread 1/2-inch rods.
 4. Horizontal Member: One, adjustable height, galvanized-steel pipe support slotted channel or plate.
 5. Pipe Supports: Roller.
 6. Hardware: Galvanized.
 7. Height: 36 inches above grade, floor, or roof.
- E. High-Profile, Multiple-Pipe Stand:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 2. Bases: Two or more; vulcanized rubber.
 3. Vertical Members: Two or more, galvanized-steel channels.
 4. Horizontal Members: One or more, adjustable height, galvanized-steel pipe support.
 5. Pipe Supports: Roller.
 6. Hardware: Galvanized steel.
- 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.

2.9 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.10 OUTDOOR EQUIPMENT STANDS

- A. Description: Individual foot supports with elevated adjustable channel cross bars and clamps/fasteners/bolts for ground or roof supported outdoor equipment components,

without roof membrane penetration, in a prefabricated system that can be modularly assembled on site.

- B. Foot Material: Rubber or polypropylene.
- C. Rails Material: Hot dip galvanized carbon steel.
- D. Wind/Sliding Load Resistance: Up to 100 mph minimum.

2.11 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.1 INSERTS

- A. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- B. Where concrete slabs form finished ceiling, provide inserts to be flush with slab surface.

3.2 PIPE HANGERS AND SUPPORTS

- A. Comply with MSS SP-58 for pipe-hanger selections and applications.
- 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 framing systems and attachments for general service applications.
- E. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- F. Use thermal-hanger shield inserts for insulated piping and tubing.
- G. Install hangers to provide minimum ½ inch space between finished covering and adjacent work.
- H. Place a hanger within 12 inches of each horizontal elbow.
- I. Provide hangers with 1-1/2-inch minimum vertical adjustment.
- J. Provide additional structural support where required to prevent pipe movement and sway.
- K. Support riser piping independently of connected horizontal piping.
- L. Support piping as follows:

Nominal Pipe Size	Single Rod Diameter	Thickness of Insulation Shield	Maximum Spacing Ferrous Piping	Copper Tubing	HDPE, PVC, Plastic Piping
3/4" & Under	3/8"	16 gauge	6'	5'	2.5'
1"	3/8"	16 gauge	7'	6'	3'
1 1/4"	3/8"	16 gauge	8'	8'	4'
1 1/2" & 2"	3/8"	16 gauge	9'	8'	4'

2 ½" & 3"	½"	12 gauge	12'	8'	4'
4" & 5"	5/8"	12 gauge	14'	8'	4'
6"	¾"	10 gauge	14'	8'	4'
8"	7/8"	8 gauge	14'	10'	5'

END OF SECTION 23 05 29

SECTION 23 05 30 – METAL FABRICATIONS AND STRUCTURAL STEEL

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work included: Provide all miscellaneous metal and metal fabrications, complete, in place, as shown on the drawings, specified herein, or needed for a complete and proper installation and not specifically called for under other sections of these specifications.

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 230100 - GENERAL PROVISIONS FOR MECHANICAL WORK

1.3 QUALITY ASSURANCE

- A. Standards: Comply with standards specified herein.
- B. Qualifications of personnel: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.
- C. Welding: Perform all shop and field welding required in connection with the work of this section, adhering strictly to the current pertinent recommendations of the American Welding Society.

1.4 PRODUCT HANDLING

- A. Protection: Use all means necessary to protect the materials of this section before, during, and after installation and to protect the work and materials of all other trades.
- B. Replacement: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the owner.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

- A. Metal surfaces, general: For fabrication of the work of this section which will be exposed to view, use only those materials which are smooth and free from surface blemishes including pitting, seam marks, roller marks, rolled trade names, and roughness.
- B. Standards: All materials shall comply with:
 - 1. Steel plates, shapes, and bars: ASTM A36.
 - 2. Steel plates to be bent or cold formed: ASTM A283, Grade C.
 - 3. Steel tubing, hot-formed, welded, or seamless: ASTM A501.
 - 4. Steel bars and bar-size shapes: ASTM A306, Grade 65, or ASTM A36.
 - 5. Cold-finished steel bars: ASTM A108, grade as selected by the fabricator.
 - 6. Cold-rolled carbon steel sheets: ASTM A336.
 - 7. Galvanized carbon steel sheets: ASTM A526, with ASTM A525, G90 zinc coating.
 - 8. Gray iron castings: ASTM A48, Class 30.

9. Non-shrink nonferrous grout: CE CRD C588.

2.2 FASTENERS

- A. General: Provide zinc-coated fasteners for exterior use and where built into exterior walls. Select fasteners for the type, grade, and class required.
- B. Standards: All fasteners shall comply with:
 1. Bolts and nuts: Regular hexagon-head type, ASTM A307, Grade A.
 2. Lag bolts: Square-head type, Fed. Spec. FF-B-561.
 3. Machine screws: Cadmium plated steel.
 4. Masonry anchorage devices: Expansion shields.

2.3 PAINT PRIMER

- A. Standard primer: SSPC Paint System Guide No. 7.00.

2.4 FABRICATION

- A. Workmanship
 1. Use materials of size and thickness shown or, if not shown, of required size and thickness to produce strength and durability in the finished product.
 2. Work to dimensions shown or accepted on the shop drawings, using proven details of fabrication and support.
 3. Use type of materials shown or specified for the various components of the work.
 4. Form exposed work true to line and level, with accurate angles and surfaces and with straight sharp edges.
 5. Ease the exposed edges to a radius of approximately 1/32" unless otherwise shown.
 6. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
 7. Weld corners and seams continuously, complying with AWS recommendations. At exposed connections, grind exposed welds smooth and flush, match, and blend with adjoining surfaces.
 8. Form exposed connections with hairline joints, flush and smooth.
 9. Provide for anchorage of the type shown. Coordinate with supporting structure. Fabricate and space the anchoring devices to provide adequate support for intended use.
 10. Cut, reinforce, drill, and tap miscellaneous metal work as indicated to receive finish hardware and similar items.

2.5 SHOP PAINTING

- A. Shop paint miscellaneous metal work, except members or portions of members to be embedded in concrete or masonry, surfaces, and edges to be field welded, and galvanized surfaces, unless otherwise specified.
- B. Remove scale, rust, and other deleterious materials before applying shop coat.
- C. Use painting methods which will result in full coverage of joints, corners, edges, and exposed surfaces.

2.6 MISCELLANEOUS METAL FABRICATIONS

- A. Rough Hardware

1. Provide bent or otherwise custom fabricated bolts, plates, anchors hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete and other structures.
 2. Manufacture or fabricate items of sizes, shapes, and dimensions required.
 3. Provide malleable iron washers for heads and nuts which bear on wood structural connections; elsewhere furnish steel washers.
- B. Loose bearing and leveling plates:
1. Provide loose bearing and leveling plates for steel items bearing on concrete construction, made flat, free from warps or twists, and of required thickness and bearing area.
 2. Drill plates to receive anchor bolts and for grouting as required.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine the areas and conditions under which miscellaneous metal items are to be installed, and correct conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Setting loose plates:
1. Clean concrete bearing surfaces free from bond-reducing materials and roughen to improve bond to surfaces. Clean the bottom surface of bearing plates.
 2. Set loose leveling and bearing plates on wedges, or other adjustable devices.
 3. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shim; but if protruding, cut off flush with the edge of the bearing plate before packing with grout.
 4. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.
- B. Fastening to in-place construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction including threaded fasteners for concrete inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.
- C. Cutting, fitting, and placement:
1. Perform cutting, drilling, and fitting required for installation of miscellaneous metal fabrications.
 2. Set work accurately in location, alignment, and elevation, and make plumb, level, true, and free from rack, measured from established lines and levels.
 3. Provide temporary bracing or anchors in formwork for items which are to be built into concrete or similar construction.
 4. Fit exposed connections accurately together to form tight hairline joints.
 5. Weld connections which are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
 6. Grind exposed joints smooth and touch up shop paint coat. Do not weld, cut, or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.

- D. Field Welding: Comply with AWS code for procedures of manual shielded metal-arc welding, appearance and quality of weld made, and methods in correcting welding work.
- E. Touch up painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting. Apply by brush or spray to provide minimum dry film thickness of 0.051 mm (2.0 mils).

END OF SECTION 23 05 30

SECTION 23 05 48 – VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 – GENERAL

1.1 SUMMARY

- A. This specification includes vibration isolation, equipment balancing requirements and sound level criteria for equipment spaces and exterior mounted equipment.
- B. Mechanical and electrical equipment and associated piping and ductwork shall be mounted on vibration isolators as specified and/or required to minimize transmission of vibration and structure-borne noise to building structure or spaces.
- C. It is the intent of the seismic portion of this specification to keep all mechanical and electrical building system components in place during a seismic event.
- D. All rotating equipment shall be balanced both statically and dynamically. The equipment when mounted and placed in operation shall not exceed a self-excited vibration velocity of 0.10 inches per second in the vertical, horizontal, or axial directions when measured with a vibration meter on the bearing caps or at the equipment mounting feet if the bearings are concealed.
- E. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Elastomeric isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Open-spring isolators.
 - 5. Housed-spring isolators.
 - 6. Restrained-spring isolators.
 - 7. Housed-restrained-spring isolators.
 - 8. Pipe-riser resilient support.
 - 9. Resilient pipe guides.
 - 10. Air-spring isolators.
 - 11. Restrained-air-spring isolators.
 - 12. Elastomeric hangers.
 - 13. Spring hangers.
 - 14. Snubbers.
 - 15. Restraints - rigid type.
 - 16. Restraints - cable type.
 - 17. Restraint accessories.
 - 18. Post-installed concrete anchors.
 - 19. Concrete inserts.
 - 20. Vibration isolation equipment bases.
 - 21. Restrained isolation roof-curb rails.
- F. Related Requirements:
 - 1. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are

applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.

2. Section 230100 - GENERAL PROVISIONS FOR MECHANICAL WORK

1.2 DEFINITIONS

- A. Designated Seismic System: An HVAC component that requires design in accordance with ASCE/SEI 7, Ch. 13, and for which the Component Importance Factor is greater than 1.0.
- B. All equipment or systems with a component importance factor of 1.0 [$I_p=1.0$] is referred to as "Life Safety" (stay in place) for equipment that must remain in place during an earthquake without regard to its ability to remain functional, it certifies that the anchoring system for isolated or non-isolated equipment will not fail, and the equipment will not fall onto building occupants or other essential equipment.
- C. All equipment or systems with a component importance factor of 1.5 [$I_p=1.5$] is referred to "Essential" (stay in place and remain operational) for equipment that not only meets the above conditions but must not fail internally or externally. This requires an independent dynamic seismic analysis of the equipment for a Certificate of Compliance and may require modification of the unit by the manufacturer or the system by the contractor. This factor also applies to components containing hazardous materials and to components in or attached to an Occupancy Category IV structure and its failure could impair the continued operation of the facility.
- D. IBC: International Building Code.

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product.
 - 2. Detail fabrication and assembly of equipment bases.
 - 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.
- B. Delegated Design Submittals:
 - 1. For each seismic-restraint device, including seismic-restrained mounting, pipe-riser resilient support, snubber, seismic restraint, seismic-restraint accessory, concrete anchor and insert, and restrained isolation roof-curb rail that is required by this Section or is indicated on Drawings, submit the following:
 - a. Seismic Restraint, and Vibration Isolation Base Selection: Select vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
 - b. 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 by professional engineer that riser system was examined for excessive stress and that none exists.
 - c. Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.

- d. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
 - e. Qualified Professional Engineer: All designated-design submittals for seismic- and wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
2. Seismic Restraint Detail Drawing:
- a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.
3. All delegated design submittals for seismic-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
4. Product Listing, Preapproval, and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and basis for approval (tests or calculations).
5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For professional engineer and testing agency.
- C. Welding certificates.
- D. Field quality-control reports.
- E. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-10 Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.
 - 1. Provide equipment manufacturer's written certification for each designated active mechanical seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction or experience data as permitted by ASCE/SEI 7-10.

2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-10.
3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.
4. The following HVAC systems and components are Designated Seismic Systems and require written special certification of seismic qualification by manufacturer:
 - a. Rooftop air handling units, variable air volume boxes, ceiling fans, mini-split systems, exhaust/supply fans, electric unit heaters.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-spring isolators and restrained-air-spring isolators to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that require periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Mason Industries, Amber/Booth Company, Vibration Elimination Co., Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic load control system.
 1. Seismic Performance: Equipment to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7-10.
- B. Consequential Damage: Provide additional seismic restraints for suspended HVAC components or anchorage of floor-, roof-, or wall-mounted HVAC components as indicated in ASCE/SEI 7-10 so that failure of a non-essential or essential HVAC component will not cause failure of any other essential architectural, mechanical, or electrical building component.
- C. Fire/Smoke Resistance: Seismic restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723 and be so labeled.
- D. Component Supports:
 1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-10 Section 13.6.

2.3 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Source Limitations: Obtain elastomeric isolation pads from single manufacturer.
2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
5. Surface Pattern: Smooth, ribbed, or waffle pattern.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient and elastomeric.
 - a. Surface Pattern: Smooth, ribbed, or waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.4 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

1. Source Limitations: Obtain double-deflection, elastomeric isolation mounts from single manufacturer.
2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolt.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.5 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:

1. Source Limitations: Obtain restrained elastomeric isolation mounts from single manufacturer.
2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - a. Housing: Cast-ductile iron or welded steel.
 - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.6 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Source Limitations: Obtain freestanding, laterally stable, open-spring isolators from single manufacturer.

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 rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates limit floor load to 500 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.7 HOUSED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:
 1. Source Limitations: Obtain freestanding, laterally stable, open-spring isolators in two-part telescoping housing from single manufacturer.
 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 rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
 - b. Top housing with attachment and leveling bolt.

2.8 RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
 1. Source Limitations: Obtain restrained-spring isolators from single manufacturer.
 2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
 - b. Top plate with threaded mounting holes.
 - c. Internal leveling bolt that acts as blocking during installation.
 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 HOUSED-RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:
 - 1. Source Limitations: Obtain freestanding, open-spring isolators with vertical-limit stop restraints from single manufacturer.
 - 2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
 - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.10 PIPE-RISER RESILIENT SUPPORT

- A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch-Thick Neoprene:
 - 1. Source Limitations: Obtain all-directional, acoustical pipe anchor from single manufacturer.
 - 2. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 - 3. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.11 RESILIENT PIPE GUIDES

- A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch-Thick Neoprene:
 - 1. Source Limitations: Obtain resilient pipe guides from single manufacturer.
 - 2. Factory-Set Height Guide with Shear Pin: Shear pin to be removable and re-insertable to allow for selection of pipe movement. Guides to be capable of motion to meet location requirements.

2.12 AIR-SPRING ISOLATORS

- A. Freestanding, Single or Multiple, Compressed-Air Bellows:
 - 1. Source Limitations: Obtain air-spring isolators from single manufacturer.
 - 2. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
 - 3. Maximum Natural Frequency: 3 Hz.
 - 4. Operating Pressure Range: 25 to 100 psig.

5. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
6. Automatic leveling valve.

2.13 RESTRAINED-AIR-SPRING ISOLATORS

- A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint:
 1. Source Limitations: Obtain restrained-air-spring isolators from single manufacturer.
 2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
 - b. Top plate with threaded mounting holes.
 - c. Internal leveling bolt that acts as blocking during installation.
 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 7. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
 8. Maximum Natural Frequency: 3 Hz.
 9. Operating Pressure Range: 25 to 100 psig.
 10. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
 11. Automatic leveling valve.

2.14 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
 1. Source Limitations: Obtain elastomeric hangers from a single manufacturer.
 2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.15 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
 1. Source Limitations: Obtain spring hangers from single manufacturer.

2. 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.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.16 SNUBBERS

- A. Source Limitations: Obtain snubbers from single manufacturer.
- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-14 Ch. 17 for 2015 or 2018 IBC.
 2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
 3. Anchors in Masonry: Design in accordance with TMS 402.
 4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

2.17 RESTRAINTS - RIGID TYPE

- A. Source Limitations: Obtain rigid-type restraints from single manufacturer.
- B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.18 RESTRAINTS - CABLE TYPE

- A. Source Limitations: Obtain cable-type restraints from single manufacturer.
- B. Seismic-Restraint Cables: ASTM A1023/A1023M galvanized cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.
- C. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.19 RESTRAINT ACCESSORIES

- A. Source Limitations: Obtain restraint accessories from single manufacturer.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.20 POST-INSTALLED CONCRETE ANCHORS

- A. Mechanical Anchor Bolts:
 - 1. Source Limitations: Obtain mechanical anchor bolts from single manufacturer.
 - 2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.
- B. Adhesive Anchor Bolts:
 - 1. Source Limitations: Obtain adhesive anchor bolts from single manufacturer.
 - 2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
- C. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-10, Ch. 13.
 - 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
 - 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.
- D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 HP that is not vibration isolated.
 - 1. Undercut expansion anchors are permitted.

2.21 CONCRETE INSERTS

- 1. Source Limitations: Obtain concrete inserts from single manufacturer.
- 2. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.
- 3. Comply with ANSI/MSS SP-58.

2.22 VIBRATION ISOLATION EQUIPMENT BASES

- A. Source Limitations: Obtain vibration isolation equipment bases from single manufacturer.

- B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails to have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases to have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- D. Concrete Inertia Base: Factory-fabricated or field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases to have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 - 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.23 RESTRAINED ISOLATION ROOF-CURB RAILS

- A. Source Limitations: Obtain restrained isolation roof-curb rails from single manufacturer.
- B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic forces.
- C. Upper Frame: To provide continuous support for equipment and to be captive to resiliently resist seismic forces.
- D. Lower Support Assembly: To be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. Lower support assembly to have a means for attaching to building structure and a wood nailer for attaching roof materials, and to be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly. Mount adjustable, restrained-spring isolators on elastomeric vibration isolation pads and provide access ports, for level adjustment, with removable waterproof covers at all isolator locations. Locate isolators so they are accessible for adjustment at any time during the life of the installation without interfering with integrity of roof.

- E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
- F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counter flashed over roof materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- 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 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.
- D. Flexible connections shall be provided for all connections indicated on drawings, manufactured of materials suitable for the operating temperatures and pressures of the fluid or gas it is conveying.
 - 1. Flexible hose shall be installed in accordance with the manufacturer's recommendations including placement in the pipeline without damage, misalignment or change in its normal length. Prior to filling the system, the alignment and length shall be checked by loosening the flange bolts to determine the installation conditions. The piping installation shall be corrected if necessary and the flexible hose replaced if damaged, at no cost to the Owner.

3.3 INSTALLATION OF VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICES

- A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Devices Schedules, where indicated on Drawings, or where Specifications indicate they are to be installed on specific equipment and systems.
- B. Provide seismic-restraint devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
- C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- D. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- E. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- F. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- G. Piping Restraints:
1. Comply with requirements in MSS SP-127.
 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 3. Brace a change of direction longer than 12 feet.
 4. Pipe Exclusions
 - a. Gas piping less than 1" inside diameter.
 - b. Piping in boiler and mechanical rooms less than 1 1/4" inside diameter.
 - c. All other piping less than 2 1/2" inside diameter.
 - 1) All piping suspended by clevis hangers where the distance from the top of the pipe to the suspension point is 12" or less.
 - 2) All trapezed piping where the distance from the suspension point to the trapeze member is 12" or less.
 - 3) If any suspension location in the run exceeds the above, the entire run must be braced.
- H. Ductwork Restraints:
1. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." and ASCE/SEI 7.
 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 3. Brace a change of direction longer than 12 feet.
 4. Select seismic-restraint devices with capacities adequate to carry static and seismic loads.
 5. Install cable restraints on ducts that are suspended with vibration isolators.
 6. Ductwork Exclusions
 - a. Rectangular and square and ducts that are less than 6 square feet in cross sectional area.
 - b. Oval ducts that are less than 6 square feet in cross sectional area based on nominal size.
 - c. Round duct less than 28" in diameter.
 - d. All trapezed ductwork where the distance from the suspension point to the trapeze member is 12" or less.

- e. Ductwork hung with straps where the top of the duct is 12" or less from the suspension point and the strap has 2 #10 sheet metal screws within 2" of the top of the duct.
 - f. If any suspension location in the run exceeds the above, the entire run must be braced.
 - I. Install seismic-restraint cables so they do not bend across edges of adjacent equipment or building structure.
 - J. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
 - K. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
 - L. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
 - M. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
 - N. Mechanical Anchor Bolts:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.
- 3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION
- A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties" for piping flexible connections.
- 3.5 INSTALLATION OF AIR-SPRING ISOLATORS
- A. Independent Isolator Installation:
 - 1. Install tank valve into each air isolator.
 - 2. Inflate each isolator to height and pressure specified on submittal.
- 3.6 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

- A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate dimensions of steel equipment rails and bases, concrete inertia bases, and restrained isolation roof-curb rails with requirements of isolated equipment specified in this and other Sections. Where dimensions of these bases are indicated on Drawings, dimensions may require adjustment to accommodate actual isolated equipment.

3.7 ADJUSTING

- A. Adjust isolators after system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.8 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. Tests and Inspections:
 - 1. Perform tests and inspections with the assistance of a factory-authorized service representative.
 - 2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
 - 4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 5. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
 - 6. Test to 90 percent of rated proof load of device.
 - 7. Measure isolator restraint clearance.
 - 8. Measure isolator deflection.
 - 9. Verify snubber minimum clearances.
 - 10. Test and adjust restrained-air-spring isolator controls and safeties.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Units will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 23 05 48

SECTION 23 05 53 – IDENTIFICATION OF HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

- A. Identification of products installed under Division 23 including:
 - 1. Plastic Nameplates
 - 2. Plastic Tags
 - 3. Metal Tags
 - 4. Stencils and Paint
 - 5. Plastic Pipe Markers
 - 6. Plastic Tape Pipe Markers
 - 7. Underground Plastic Tape Pipe Markers

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 230100 - GENERAL PROVISIONS FOR MECHANICAL WORK

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product indicated.
 - 2. Piping and Equipment Label Schedule: Include a listing of all piping and equipment to be labeled with the proposed content for each label.
 - 3. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
 - 4. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Valve Schedules for each piping system to include in operation and maintenance manuals.

1.5 REFERENCES

- A. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Brady Corp., Craftmark Pipe Markers, Seton Identification Products.

2.2 Color: Unless specified otherwise, conform with ANSI/ASME A13.1.

2.3 Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light contrasting background color.

- 2.4 Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2-inch square.
- 2.5 Metal Tags: Brass or aluminum with stamped letters; tag size minimum 1-1/2-inch diameter with smooth edges.
- 2.6 Stencils: With clean cut symbols and letters of following size:

Outside Diameter of Insulation or Pipe	Length of Color Field	Size of Letters
3/4" - 1-1/4"	8"	1/2"
1-1/2" - 2"	8"	3/4"
2-1/2" - 6"	12"	1-1/4"
8" - 10"	24"	2-1/2"
Over 10"	32"	3-1/2"

- A. Stencil Paint: Semi-gloss enamel black unless otherwise indicated.
- 2.7 Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and fluid being conveyed.
- 2.8 Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- 2.9 Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape of not less than 6-inch-wide by 4 mil thick, manufactured for direct burial service.
- A. Underground plastic piping to be installed with a tracer wire.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials and to accept stencil painting.

3.2 INSTALLATION

- A. Plastic Nameplates: Install with corrosive-resistant mechanical fasteners, or adhesive.
- B. Plastic or Metal Tags: Install with corrosive-resistant chain.
- C. Stencil Painting: Apply in accordance with manufacturer's instructions.
- D. Plastic Pipe Markers: Install in accordance with manufacturer's instructions.
- E. Plastic Tape Pipe Markers: Install complete around pipe in accordance with manufacturer's instructions.
- F. Underground Plastic Pipe Markers: Install 6 to 8 inches below finished grade, directly above buried pipe.
- G. Equipment: Identify HVAC equipment such as but not limited to air handling equipment, condensing units, chillers, pumps, storage tanks, expansion tanks, water treatment devices etc. with plastic nameplates. Small devices, such as in-line pumps, may be identified with plastic or metal tags.

- H. Controls: Identify control panels and major control components outside panels with plastic nameplates.
- I. Valves: Identify valves in main and branch piping with tags.
- J. Piping: Identify piping, concealed, or exposed, with plastic pipe markers or plastic tape pipe markers. Stenciled painting may be used on insulation. Tags may be used on small diameter piping. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and "T", at each side of penetration of structure or enclosure, and at each obstruction.

3.3 VALVES AND CHARTS

- A. The Contractor under this Division shall attach a numbered brass tag to each valve installed under this Contract. Each number shall be prefixed with the "H" for hydronic valves. Tags shall be attached to the valves by means of brass "S" hooks. Tags shall be Seton Name Plate Co., C.H. Hanson Co. or Identifications.
- B. A chart headed "HYDRONIC VALVE CHART" shall be prepared. Three original charts shall be prepared and approved by the engineer. One of each approved type chart shall be framed under glass and mounted on the wall in the main mechanical room where directed. Three photocopies of each chart shall be made and shall be submitted through normal shop drawing channels for approval and subsequent owner's files. Each chart shall be formatted as shown below: (All normally closed valves shall have a brass tag marked Normally Closed.)

HYDRONIC VALVE CHART

PROJECT NAME

DATE

TAG NO.	VALVE LOCATION	VALVE TYPE/SIZE	VALVE FUNCTION

END OF SECTION 23 05 53

SECTION 23 05 93 – TEST, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL SPECIFICATIONS

1.1 DESCRIPTION OF WORK

- A. The total system balance shall be performed by an independent test and balance firm that specializes in testing and balancing of HVAC systems.
- B. This specialty firm shall perform the following:
 - 1. On-going job site inspections of equipment, controls, and metering devices during construction to verify conformance with design specifications.
 - 2. Air System Balance
 - a. Outside Air Systems
 - b. Supply Air Systems
 - c. Return Air Systems
 - d. Exhaust Air Systems
 - 3. Control Systems Verification

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 230100 - GENERAL PROVISION'S FOR MECHANICAL WORK

1.3 DEFINITIONS

- A. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers.
- B. HVAC: Heating, Ventilating and Air Conditioning.
- C. NAS: National Account Services. An enhanced program of testing and balancing offering an expanded range of services including a Quality Assurance Guaranty.
- D. TAB: Testing, Adjusting and Balancing of HVAC systems to meet design objectives and obtain optimum system performance.
- E. TBE: Test and Balance Engineer is an individual certified by AABC or NEBB as having a degree in engineering and 3 years of test and balance experience, or, 5 years of background in the air conditioning field and 5 years continuous field experience in testing and balancing work.

1.4 REFERENCES

- A. 2011 ASHRAE Handbook, HVAC Applications, Chapter 38, Testing, Adjusting and Balancing.

1.5 AGENCY QUALIFICATIONS

- A. Testing and Balancing (TAB) Agency shall be a member of the AABC or NEBB.
- B. A certified Test-and-Balance Engineer (TBE) shall be responsible for certification of the total work of this section.
- C. All work shall be performed in accordance with AABC National Standards. If these specifications set forth more stringent requirements than the AABC National Standards, these specifications shall prevail.

1.6 QUALIFICATION SUBMITTALS

- A. Testing and Balancing (TAB) Agency shall submit a company resume listing personnel and project experience in the field of air system balancing.
- B. TAB Agency shall furnish all necessary calibrated instrumentation to adequately perform the specified products. TAB Agency shall submit an inventory and calibration data of all instruments and devices in possession of the balancing agency, to enable the Owner, or his representative, to evaluate the balancing agency's performance capability.
- C. The TAB Agency shall, upon acceptance of the contract, submit to the Owner, or the Owner's representative, a "Quality Assurance Guaranty".
- D. Within 30 days after acceptance of the contract, the TAB Agency shall submit to the Design Engineer a working agenda which will include procedures for testing and balancing each type of air flow system. The Test and Balance Report format will also be submitted indicating data to be recorded.

1.7 NOTIFICATION AND SCHEDULING

- A. A pre-balance conference shall be held prior to job start as scheduled by the Tab Agency. Attendees at the meeting shall include representatives of the Test and Balance (TAB) Agency, General Contractor, Mechanical Sub Contractor, Control Sub Contractor, Owner and Mechanical Engineer.
- B. The schedule for testing and balancing the HVAC system shall be established by the General Contractor, and/or Owner's representative, in coordination with the TAB Agency on a critical path network.
- C. The TAB Agency is responsible for initiating this continuing coordinating to determine schedule for final testing and balancing services.
- D. It will be necessary for the TAB Agency to perform its services in close coordination with the Mechanical Contractor, with all scheduling and deficiencies reported through the General Contractor, and/or Owner's representative.
- E. Before testing and balancing commences, the TAB Agency shall receive notification in writing from the Mechanical Contractor that the system is operational, complete, and ready for balancing.
- F. A completed system means more than just physical installation. The Mechanical Contractor shall certify that all prime movers; fans, refrigeration machines, etc., are installed in good working order, and that full load performance has been preliminarily tested.
- G. The Mechanical Contractor shall certify in writing that all equipment has been checked, started, and adjusted by the manufacturer and operated for the specified period.

1.8 COORDINATION WITH OTHER TRADES

- A. To bring the HVAC system into a state or readiness for testing adjusting and balancing, the Mechanical Contractor shall perform the following:
 - 1. Air Distribution Systems
 - a. Ensure that all splitters, extractors, volume, smoke, and fire dampers are properly located and functional. Dampers serving requirements of smoke, minimum and maximum outside, return, relief, and exhaust air shall provide tight closure and full opening, with a smooth and free operation.
 - b. Verify that all supply, return, exhaust, and transfer grilles, registers, diffusers, and high-pressure terminal units are installed and operational.

- c. Ensure that air handling systems, units, and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc. are blanked and/or sealed to eliminate excessive bypass or leakage of air.
 - d. Ensure that all fans (supply, return, relief, and exhaust) are operating and free of vibration. All fans and drives shall be checked for proper fan rotation and belt tension. Overload protection shall be of proper size and rating. A record of motor current and voltage shall be made to verify that the motors do not exceed nameplate rating.
 - e. Make any necessary changes to the sheaves, belts, and dampers, as required by the TAB Agency, at no additional cost to Owner.
 - f. Install clean filters prior to testing.
- B. The Temperature Control Subcontractor Shall Perform the Following:
 - 1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air resets, and fire and freeze stats.
 - 2. Verify that all controlling instruments are calibrated and set for design operating conditions.
 - 3. Calibrate room thermostats after installation and before the thermostat control verification tests are performed. The Test and Balance (TAB) Agency shall verify the accuracy of final settings by taking temperature readings. The readings shall be in a typical conditioned space for each separately controlled zone.
 - 4. The Control Contractor shall allow sufficient time in the project to provide assistance and instruction to the TAB Agency in the proper use and setting of control components such as, but not limited to, computers, static pressure controllers, or any other device that may need set points changed so that the testing and balancing work can be performed.
- C. The General Contractor and/or Owner's representative, Mechanical Contractor, Temperature Control Subcontractor, and the suppliers of the HVAC equipment shall all cooperate with the TAB Agency to provide all necessary data on the design and proper application of the system components. In addition, they shall furnish all labor and materials required to eliminate any system deficiencies.
- D. In coordination with the General Contractor and/or Owner's representative, the TAB Agency shall arrange for an area of ample size and convenient location for storage of tools, equipment, and other items as required.

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

3.1 ON-GOING JOB SITE INSPECTIONS

- A. During construction, the balancing agency shall inspect the installation of pipe systems, sheet metal work, temperature controls, and other component parts of the HVAC systems. Inspections shall be conducted a minimum of 3 times. (Typically, this is performed when 60% of the duct work is installed and again when 90% of the total system is installed and prior to insulation of the piping.)
- B. The balancing agency shall submit a written report of each inspection to the Owner or owner's representative, and the contractors responsible for correcting noted deficiencies.
- C. Check for necessary balancing hardware (dampers, flow meters, valves, pressure taps, thermometer wells, etc.) to determine if they are installed properly and readily accessible.

- D. Identify and evaluate any variations from system design.
- E. Identify and report possible restrictions in systems (closed fire dampers, long runs of flexible duct, poorly designed duct fittings, etc.).

3.2 AIR SYSTEM TEST AND BALANCE PROCEDURES

- A. Fan Speeds: Test and adjust fan RPM to achieve design CFM requirements.
- B. Current and Voltage: Measure and record motor current and voltage.
- C. Pitot Tube Traverse: Perform a Pitot tube traverse of main supply and return ducts to obtain total CFM. If a Pitot tube traverse is not practical, the summation of the outlets or inlets may be used. An explanation of why a traverse was not made must appear on the appropriate data sheet.
- D. Outside Air: Test and adjust system minimum outside air by Pitot tube traverse. If a Pitot tube traverse is not practical, the percentage of outside air may be determined by calculations from the return air, outside air, and mixed air temperature. Make allowances for heat of compression and motor heat where applicable.
- E. Static Pressure: Test and record system static pressures, including suction and discharge static pressure profile of each fan.
- F. Air Temperature: Take wet bulb and dry bulb air temperatures on the entering and leaving side of each cooling coil. Dry bulb temperatures shall be taken on the entering and leaving side of each heating coil.
- G. Zone Ducts (supply and return): Adjust zone ducts to within design CFM requirements. At least one zone balancing damper shall be completely open.
- H. Main Ducts: Adjust main ducts to within design CFM requirements. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.
- I. Branch Ducts: Adjust branch ducts to within design CFM requirements. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.
- J. Tolerance - test and balance each diffuser, grille, and register to within 10 percent of design requirement.
- K. Identification: Identify the location and area of each grille, diffuser, register, and terminal box. This information shall be recorded on air outlet data sheets.
- L. Description: Record the size and type of each diffuser, grille, and register on air outlet data sheets.
- M. Minimizing Drafts: Adjust all diffusers, grilles, and registers to minimize drafts in all areas.
- N. Exhaust Fans: Measure exhaust fan static pressure, total CFM, makeup air and fan RPM. Measure motor operating voltage and amperage.
- O. Measure exhaust fan static pressures, total CFM, makeup air and fan RPM.
- P. Measure motor operating voltage and amperage.
- Q. Record the specified against the actual supplied horsepower and electrical characteristics of all motors.

3.3 CONTROL SYSTEMS VERIFICATION

- A. Verify that all control devices are properly connected.
- B. Verify that all dampers, valves, and other controlled devices are operated by the intended controller.
- C. Verify that all dampers and valves are in the position indicated by the controller (open, closed or modulating).

- D. Verify the integrity of valves and dampers in terms of tightness of close-off and full-open positions. This includes dampers in multizone units.
- E. Check that all valves are properly installed in the piping system in relation to direction of flow and location.
- F. Check the calibration of all controllers.
- G. Verify the proper application of all normally open and normally closed valves.
- H. Check the location of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts, or cold walls.
- I. Check the locations of all sensors to determine whether their position will allow them to sense only the intended temperatures or pressures of the media. Control Contractor will relocate as deemed necessary by the TAB Agency.
- J. Check the sequence of operation that any control mode is in accordance with approved shop drawings. Verify that only minimum simultaneous heating and cooling occurs.
- K. Verify that all controller set points meet the design intent.
- L. Check all dampers for free travel.
- M. Verify the operation of all interlock systems.
- N. Perform all system verification to assure the safety of the system and its components.

3.4 SYSTEM PERFORMANCE VERIFICATION

- A. At the time of final inspection, the Test and Balance (TAB) Agency shall recheck, in the presence of the Owner's Representative, specific and random selections of data, air quantities, and air motion recorded in the Certified Report.
- B. Points and areas for recheck shall be selected by the Owner's Representative.
- C. Measurement and test procedures shall be the same as approved for work forming basis of Certified Report.
- D. Selections for recheck, specific plus random, will not normally exceed 25 percent of the total number tabulated in the report, except that special air systems may require a complete recheck for safety reasons.
- E. If random tests elicit a measured flow deviation of ten percent or more from that recorded in the Certified Report listings, by ten percent or more of the selected recheck stations, the report is rejected, all systems shall be readjusted and tested, new data recorded, new Certified Report submitted, and new inspection tests made, all at no additional cost to Owner.
- F. Following system verification of the Certified Report by the Owner's Representative, the settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked by the TAB Agency, so that adjustment can be restored if disturbed at any time. Devices shall not be marked until after system verification.
- G. Opposite Season Test
 - 1. The Testing and Balancing (TAB) Agency shall perform an inspection of the HVAC system during the opposite season from that in which the initial adjustments were made. The TAB Agency shall make any necessary modifications to the initial adjustments to produce optimum system operation.

3.5 RECORD AND REPORT DATA

- A. The Test and Balance Report shall be complete with logs, data and records as required herein. All logs, data and records shall be typed on white bond paper and bound. The

report shall be certified accurate and complete by the Testing and Balancing (TAB) Agency's certified Test and Balance Engineer.

- B. Copies of the Test and Balance Report are required and shall be submitted to the Owner, or the Owner's representative.
- C. The report shall contain the following general data in a format selected by the TAB Agency.
 - 1. Project number.
 - 2. Contract number.
 - 3. Project title.
 - 4. Project location.
 - 5. Project architect.
 - 6. Project mechanical engineer.
 - 7. Test and balance agency.
 - 8. Test and Balance Engineer.
 - 9. General contractor.
 - 10. Mechanical subcontractor.
 - 11. Date tests were performed.
 - 12. Certification.
- D. The Test and Balance Report shall be recorded on report forms conforming to the recommended forms in AABC National Standards. At a minimum, the report shall include:
 - 1. Preface: A general discussion of the system, any abnormalities and problems encountered.
 - 2. Instrumentation List: The list of instruments including type, model, manufacturer, serial number, and calibration dates.
 - 3. Air Handling Equipment
 - a. Manufacturer, model number, and serial number.
 - b. All design and manufacturer related data.
 - c. Total actual CFM by traverse if practical, if not practical, the sum of the outlets may be used, or a combination of each of these procedures. For specific systems, such as ones with diversity, see the AABC National Standards.
 - d. Suction and discharge static pressure of each fan, as applicable.
 - e. Outside air and return air total CFM.
 - f. Exhaust air total CFM.
 - g. Actual operating current, voltage, and brake horsepower of each fan motor.
 - h. Final RPM of each fan.
 - i. Fan and motor sheave manufacturer, model, size, number of grooves, and center distance.
 - j. Belt size and quantity.

- k. Static pressure controls' final operating set points.
- 4. Electric Heating Coil/Duct Heater
 - a. Manufacturer and model number.
 - b. All design and manufacturer rated data.
 - c. Actual operating current and voltage.
 - d. Coil location and identification number.

END OF SECTION 23 05 93

SECTION 23 06 00 – MECHANICAL SYSTEMS DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
 - 3. Demonstration and training recordings.

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 230100 - GENERAL PROVISION FOR MECHANICAL WORK

1.3 SUBMITTALS

- A. Instruction Program: Submit copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module
 - 1. At completion of training, submit training manual for Owner's use which includes receipts signed by the Owner acknowledging that training took place.
- B. Attendance Record: For each training module, submit list of participants and length of instruction time.
- C. Demonstration and Training Videos: Provide recording of all demonstrations and training given and submit video within ten days of end of each training module.
 - 1. Identification: Provide an applied label with the following:
 - a. Name of Project
 - b. Name of Engineer
 - c. Name of Contractor
 - d. Date video was recorded
 - e. Description of information recorded.
 - 2. Transcript: Prepared on 8-1/2-by 11-inch paper, punched and bound in heavy-duty, three ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.

1.4 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

- C. Coordinate content of training modules with operation and maintenance manual information.

PART 2 - PRODUCTS

2.1 DEMONSTRATION AND TRAINING PROGRAM

- A. Provide program that includes individual training modules for each system and equipment not a part of a system as required by individual Specification Sections and as follows, but not limited to:
 - 1. HVAC: Provide demonstration and training by showing Owner personnel the major components of the HVAC system as follows:
 - a. Electric Unit Heaters and location of each
 - b. Geothermal Well-field including exact location of well and exterior vaults
 - c. Make-up Air Units and location of each
 - d. Rooftop Units and location of each
 - e. Exhaust Fans and location of each
 - f. Air Filter replacement instructions
 - g. Fire damper resetting instructions and location of each
 - h. Instrumentation and Controls overview

PART 3 - EXECUTION

3.1 PREPARATION

- A. Assemble materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual.

3.2 INSTRUCTION

- A. Engage qualified instructors to instruct Owner personnel to adjust, operate, and maintain systems, subsystems, and equipment not a part of a system. All instructors shall be factory-certified technicians or other entity as approved by the Engineer prior to scheduling of sessions.
- B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
- C. Schedule training with Owner, through Architect/Engineer, with at least ten days' advance notice.

3.3 DEMONSTRATION AND TRAINING RECORDINGS

- A. Engage a qualified individual to record demonstration and training video(s). Record each training module separately. Include classroom instructions and demonstrations.
- B. Format: Provide high-quality DVD or thumb drive. Cloud storage is unacceptable.
- C. Narration: Describe scenes on video while recording. Include description of items being viewed.
- D. Transcript: Provide typewritten transcript of the narration.

END OF SECTION 23 06 00

SECTION 23 07 19 – HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Piping Insulation
- B. Jackets and Accessories

1.2 RELATED WORK

- A. The General and Special Conditions and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 230100 - GENERAL PROVISIONS FOR MECHANICAL WORK
- C. Section 230553 - IDENTIFICATION OF HVAC PIPING AND EQUIPMENT

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.4 QUALITY ASSURANCE

- A. Materials: Flame spread smoke developed rating of 25/50 in accordance with ASTM E84.
- B. All pipe insulation shall be installed by mechanics specializing in this type of work. The finished product shall present a neat and workmanlike appearance. Insulation shall not be applied until all tests except operating tests have been completed, all foreign material, such as rust, scale, or dirt, has been removed and the surfaces are clean and dry. Insulation shall be clean and dry when installed and during the application of any finish.
- C. The insulation, insulating materials and related items shall be delivered to the jobsite in the manufacturer's unopened containers. The containers shall have labels stating the manufacturer's name, contents, quantity and other pertinent data.

PART 2- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Insulations having the thermal and physical properties of the specific materials specified hereinafter, of any of the following manufacturers, or approved equal, are acceptable.

Armstrong	Knauf
Johns Mansville	Certain Teed/Saint Gobain
Owens-Corning	Pittsburgh Corning
Rubatex	

- B. The Engineer reserves the right to determine if the proposed insulating materials of any one manufacturer are acceptable in lieu of the specific insulation selected for the following applications.

2.2 INSULATION

- A. Type A glass fiber insulation; ANSI/ASTM C547; 'k' value of 0.23 minimum at 75 degrees F; noncombustible.
- B. Type B cellular foam; flexible, plastic; 'k' value of 0.25 minimum at 75 degrees F; ASTM C534. APArmaflex W (white) or APArmaflex SS (black) or equal.
- C. Type C calcium silicate.
 - 1. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
 - 3. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
 - 4. Calcium Silicate insulation is preferred over fiberglass in mechanical and heating plant applications, where piping is more subject to abuse.

2.3 JACKETS

- A. Vapor Barrier Jackets: Kraft reinforced foil vapor barrier with self-sealing adhesive joints.
- B. PVC Jackets: One piece, premolded type.
- C. Canvas Jackets: UL listed treated cotton fabric, 6 oz/sq yd.

2.4 ACCESSORIES

- A. Insulation Bands: 3/4 inch wide; 0.015 inch thick galvanized steel, stainless steel. 0.007 inch 0.18 thick aluminum.
- B. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum. 0.010 inch thick stainless steel.
- C. Insulating Cement: ANSI/ASTM C195; hydraulic setting mineral wool.
- D. Finishing Cement: ASTM C449.
- E. Fibrous Glass Cloth: Untreated; 9 oz/sq yd weight.
- F. Adhesives: Compatible with insulation.
- G. Treated wooden blocks.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Install materials after piping has been tested and approved.

3.2 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Continue insulation with vapor barrier through penetrations, except on fire rated walls.
- C. In exposed piping, locate insulation and cover seams in least visible locations.

- D. On insulated piping with vapor barrier, insulate fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- E. Provide an insert, not less than 6 inches long, of same thickness and contour as adjoining insulation, between support shield and piping, but under the finish jacket, on piping 2 inches diameter or larger, to prevent insulation from sagging at support points. Inserts shall be cork or other heavy density insulating material suitable for the planned temperature range. Factory fabricated inserts may be used. Insert shall extend around bottom 120 degrees of pipe barrel and shall be included inside vapor barrier jacket where applied. See Section 230529 for shields and hangers.
- F. Neatly finish insulation at supports, protrusions, and interruptions.
- G. Jackets
 - 1. Indoor, Concealed Applications: Insulated pipes shall have standard jackets, with vapor barrier, factory-applied or field-applied. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass cloth and adhesive. If piping is within a plenum, PVC jackets may not be used unless jacket material possesses a flame spread index of 25 and a smoke developed index of 50 or less in accordance with ASTM E84.
 - 2. Indoor, Exposed Applications: For pipe exposed in mechanical equipment rooms or in finished spaces, insulate as for concealed applications. Finish with canvas jacket; size for finish painting. This jacketing must be properly applied with lagging adhesive, such that the outer surface is smooth and free of wrinkles. Do not use PVC jackets. All chilled water piping insulation shall be completely sealed so that a perfect vapor barrier is achieved.
 - 3. Indoor, Field-Applied Jacket Schedule: Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket. Piping jacket shall be Stainless Steel, Type 304 or Type 316, Smooth 2B Finish: 0.020 inch thick.
 - 4. Outdoor, Field-Applied Jacket Schedule: Install jacketing on all piping to be installed outside the building per the following: foil faced, UV-resistant vapor barrier and weather barrier membrane, self-stick, self-healing, with a zero perm rating; for use on exterior duct, piping, and vessels. Jacketing shall be a high strength foil/polymer laminate coated with self-healing, self-adhering rubberized asphalt. Jacketing shall not require 'slip joints' and shall expand and contract with the system without rupture or leakage. Jacketing shall be for use as UV protection, weather protection, vapor barrier, and mechanical protection; and simple 'peel and stick' installation.
 - 5. Flanges, Valves, Anchors and Fittings: Unless otherwise specified, all flanges, valves, anchors and fittings shall be insulated with factory premolded or field fabricated segments of insulation of the same materials and thickness as the adjoining pipe insulation. When segments of insulation are used, elbows shall be provided with not less than three segments. For other fittings and valves, segments shall be cut to required curvatures, or nesting size sectional insulation shall be used. The segments of the insulation shall be properly placed and jointed with fire-resistant adhesive. After the insulation segments are firmly in place, fire-resistant vapor barrier coating shall be applied over the insulation in two coats with glass tape embedded between coats. The coating shall be applied to a total dry film thickness of 1/16 inch minimum. All glass tape seams shall be terminated neatly at the ends of the unions with insulating cement troweled on the bevel. For piping operating below ambient temperature, the beveled ends shall receive a coat of vapor barrier coating. Where anchors are used and secured directly to low temperature piping, they shall be insulated for a distance to prevent condensation, but not less than 6 inches from the surface of

the pipe insulation. For jacket facing to receive finish painting, the factory applied jacket shall be as specified herein, except that the kraft paper shall be light colored with the kraft paper exposed. Field applied vapor barrier jacket shall conform to the above conditions where finish painting is required.

INSULATION APPLICATION AND THICKNESS (inches)							
PIPE SYSTEM	TYPE	TEMP	Pipe Diameter Range (Inches)				
		RANGE DEG F	<1	1-1.5	1.5-4	4-<8	>8
Insulation Thickness (inches)							
CONDENSATE DRAIN	B		0.5	0.5	0.5	0.5	0.5
REFRIGERANT	B		0.5	1.0	1.0	1.0	1.0
DOMESTIC WATER	A/B	55- 70	1.5	1.5	1.5	1.5	1.5

END OF SECTION 23 07 19

SECTION 23 21 13.33 – GROUND-LOOP HEAT-PUMP PIPING

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Extent of ground-loop heat-pump piping work is indicated on the drawings and schedules and by requirements of this section. The ground-loop heat-pump piping consists basically of polyethylene fusion joined piping formed into vertical loops. The ground-loop heat-pump piping shall include all piping from wells, underground mains, into building mechanical room. Provide piping flanges 18" above mechanical room floor. See Drawings.
- B. In the event the contractor wishes to utilize a piping arrangement different from the designed arrangement, it is the responsibility of the contractor to submit to the Engineer for approval of his proposed arrangement. The contractor shall furnish in writing that the different arrangements will provide the same heat rejection/addition capabilities as the designed arrangement.
- C. A pre-installation meeting shall be held before any drilling can begin.
- D. Refer to Section 232113 HYDRONIC PIPING AND VALVES for continuation of the piping system in the building.

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 230100 - GENERAL PROVISIONS FOR MECHANICAL WORK
- C. Section 232113 - HYDRONIC PIPING AND VALVES
- D. Section 230553 - IDENTIFICATION OF MECHANICAL PIPING AND EQUIPMENT
- E. Section 221000 - PLUMBING PIPING AND VALVES

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product.
 - a. Pipe, fittings, and vaults.
 - b. Joining method and equipment.
 - c. Fabricator certificates.
- B. Drilling Log.

1.4 CLOSEOUT SUBMITTALS

- A. Dimensioned as-built well field drawings indicating piping mains and well locations.
- B. Drilling Log. Include in operation and maintenance manual.
- C. Antifreeze volume in piping system. Include in operation and maintenance manual.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of geothermal loop heat exchanger products and tools of the types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

- B. Installer's Qualifications: Installer must have completed a certified training program or be a certified geothermal service contractor and shall have at least two years of successful installation experience on projects with ground-loop heat-pump piping work like to that required for this project.
- C. Fabricator's Qualifications: The only acceptable method for joining buried pipe systems is by a heat fusion process. Ground-loop heat-pump piping fabricators must have completed a heat fusion school in which each participant has performed a heat fusion procedure under direct supervision of a Certified Heat Fusion Technician.
- D. Codes and Standards: Comply with all local and state laws and ordinances.
- E. Acceptable Bidders
 - 1. All bidders for earth coupled/ground loop system must have Architect/Engineer approval prior to bidding the project.
 - 2. Owner Preferred contractor according to alternate:
 - a. Geothermal Maintenance Company
 - 3. Acceptable contractors shall be as follows.
 - a. Bluegrass Geothermal, Paris, KY
 - b. E and E Drilling, Paris, KY
 - c. Jackson Geothermal, Mansfield, OH
 - d. Geothermal Earthworks, Inc., Bowling Green, KY
 - e. Geothermal Solutions, LLC, Loretto, TN.
 - f. Midsouth Geothermal, Memphis, TN
 - g. Withers Geothermal, Columbia, KY
 - h. Stafford Drilling, Greenup, KY
 - i. TCI Geothermal, Goodfield, IL
 - j. Mid State Construction Co, Livingston, TN
 - k. Durbin Geothermal, Beecher City, IL
 - 4. Any well drillers and/or earth coupled/ground loop system contractors not listed above must submit written qualifications to engineer seven (7) days (minimum) prior to bidding.
 - 5. Submittal of qualifications shall include detailed information about the company including but not limited to, the number of years in business, number of drill rigs, number of employees and list of (5) current and (5) most recently completed projects of equivalent size and scope.

1.6 STRUCTURAL DRAWINGS AND SPECIFICATIONS

- A. Each Contractor shall refer to the Structural Drawings and Specifications for the general construction of the building, for floor and ceiling heights, for location of walls, partitions, beams, grade beams, foundations, footings etc., and shall be guided accordingly for the setting of all sleeves and equipment.
- B. Under no circumstances shall a Contractor scale the Drawings for the locations of equipment and work.
- C. The contractor is responsible for reviewing all below slab / underground piping with structural components and coordinating all stepped footings or sleeves where required.

1.7 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data and installation instructions for ground-loop-heat-pump piping materials and products.
- B. Installer and Fabricator's Qualifications: Submit names and certificates of successful completion of the required schools.
- C. Record Drawings: Accurate dimensioned drawings of the geothermal loop heat exchanger shall be prepared and submitted at the time of testing and prior to backfilling.
- D. Fusion Machine: Submit manufacturer's technical data on the fusion machine to be used in fabricating the ground-loop heat-pump.

PART 2 - PRODUCTS

2.1 PIPING

- A. HDPE (High Density Polyethylene).
 - 1. Minimum cell classification 345434C per ASTM D 3350 "Standard Specification for Polyethylene Plastics Pipe and Fittings Materials". Resistance to environmental stress cracking is critical to long life expectancy. Therefore, as a more stringent requirement, the piping shall experience zero failures after 5,000 hours under condition "C" (100% reagent at 100 deg. C) when tested in accordance with ASTM D 1693, "Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics".
 - 2. All piping shall conform to the specifications and requirements of ASTM D3035-93.
 - 3. Piping 2" or less shall have a minimum dimension ratio of 11. Piping 3" and larger shall have a minimum dimension ratio of 15.5. Minimum pressure rating for all piping used in vertical bores shall be 200 psi.
- B. All fittings which are molded shall conform to the requirements of ASTM D2683 (for socket fusion fittings), ASTM D3261 (for butt/saddle fusion fittings), or ASTM F1055 (for electrical fusion fittings).
- C. Joining shall be by the socket fusion, or butt fusion method in accordance with manufacturer's Heat Fusion Qualification Guide. The operator shall be properly trained and shall have executed quality fusion joints.
- D. Pipe, tubing, or fittings fail within 25 years from the date of purchase, piping manufacturer shall supply the following:
 - 1. Replace, free of charge and freight prepaid, a quantity of new pipe, tubing, or fusion fittings equal to that proved to be defective.
 - 2. For the first five (5) years after the date of purchase pay all direct labor charges up to \$1.00 per linear foot incurred on the job site in removing the defective pipe, tubing or fusion fittings and replace the same with new pipe, tubing, or fusion fittings. For claims during the sixth (6th) through twenty-fifth (25th) years, the payment made by piping manufacturer for direct labor charges shall be reduced at a rate of five percent (5%) per year.

2.2 FUSION MACHINE

- A. The fusion machine used to make the joints shall encompass the following features:
 - 1. Guide rods shall be in a plane that passes through the centerline of the pipe thus canceling the bending forces in the machine caused by the fusion forces.
 - 2. The combination butt/saddle machine must have a mechanical advantage of at least 5.5 to 1 in the butt fashion mode, and 2.5 to 1 in the saddle fashion mode.

3. A butt fashion only machine must have a mechanical advantage of at least 10 to 1 and a saddle fusion only machine must be capable of applying at least 600 lbs. of thrust.
4. The pipe clamps shall have the strength to "round-up" the pipe close to the fusion joint. They must be adjustable for removal of high/low mismatch of pipe walls and clamp each piece on continuing straight centerline.
5. The pipe facing device shall be capable of rapid facing of the pipe ends to a perfectly flat surface, so when the ends are brought together, there is 100% plastic contact.
6. The facer shall be hand-powered for pipe sizes up to 2", and electrically powered for pipe sizes up to 8".
7. The facer shall have precisely machined stops to lock the facer squarely between the clamping jaws at the end of face off.
8. The heater plate shall be electrically heated and thermostatically controlled. The surface shall be smooth with a high quality non-stick coating. The heater shall be capable of quick heat-up and maintaining a constant surface temperature in the desired temperature range even in inclement conditions. The heater plate shall be equipped with a thermometer to indicate drastic temperature change. A surface pyrometer should be used periodically to assure proper temperature.

2.3 BASIC IDENTIFICATION

- A. General: Provide identification complying with Section 230553 - IDENTIFICATION OF MECHANICAL PIPING AND EQUIPMENT in accordance with the following listing:

1. Underground Piping: Underground-type plastic pipe markers.

2.4 GEOTHERMAL WELL VAULT

- A. General

1. This specification designates the requirements for the geothermal vault (valve pit) including internal pipe, fittings, and valves. The packaged system shall be similar to custom made Atlantis heavy duty polyethylene vault. At contractor's option, a concrete vault may be submitted. Install vault in strict accordance with manufacturer's requirements.

- B. External Shell

1. The external shell shall be constructed of high-density polyethylene flat stock having a cell classification of 345444 with a UV stabilizer of C. All materials used shall have a minimum thickness of 1". Internal and external seams are heat welded using high density polyethylene welding rods having a cell classification of 345444C. All seams are nitrogen tested. Walls to be 72" high, with a 30" manhole with ladder. The manhole lid is connected with 8-3/8" stainless steel counter sunk bolts. Lid to have 5000-pound load bearing capacity. Provide vault with sump pit and sump pump. See plumbing drawings and specification for sump pump (SP-3) requirements. Provide 1" conduit from vault to where geothermal piping mains are terminated in building. See Drawings. Coordinate all work with Plumbing Contractor and Electrical Contractor.

- C. Internal Bracing

1. Bracing shall be spaced at a maximum of 30" and constructed of a minimum of 1" thick high-density polyethylene flat stock heat welded to the external shell with high density polyethylene welding rods.

D. Internal Piping

1. Piping shall be constructed of CPChem Performance Driscoplex 5300 Climate Guard TM High Density Polyethylene DR 15.5 pipe having a cell classification of 345444 with a UV stabilizer of C. This internal pipe is constructed in an offset, over and under, model for supply and return lines. All joints to be heat fused. The entire piping system to be tested using 150 psi nitrogen. The main supply and return pipe to be shipped with cap butt welded to pipe. All pipe penetrating the vault walls shall be DR 11 and heat welded to the external shell.

E. Fittings

1. P/T Plugs shall be constructed of solid brass and have a dual seal core of Nordel, Good up to 350 degrees F for water. Plugs shall be rated zero leakage from vacuum 1000 psig and can receive a pressure or temperature probe.
2. Butterfly Valve shall be constructed of a cast iron body, 416 stainless steel stem with a lever shut off system.
3. 90 Degree Elbows shall be molded out of high-density polyethylene resins in accordance with the requirements of ASTM 3261.
4. Branch and Service Saddles shall be molded out of high-density polyethylene resins in accordance with the requirements of ASTM 3261.
5. Provide integral circuit setters near the header on the return line for each loop.
6. Provide test/flushing ports on circuit in vault.

F. Installation

1. The vault shall be lowered into a pit 105" deep with a 6" bed of #57 gravel. Once the vault is in place, concrete is poured 36" deep and 12" thick around the vault to balance buoyancy pressure and allow for anchoring. Install sump pump, float controls and 1 1/4" polyethylene discharge piping. See details on Drawings. The Contractor shall confirm all vault sizes and piping layouts.

PART 3 - EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which ground-loop heat-pump piping systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 EARTHWORK

- A. Excavating, trenching, warning tape, and backfilling are specified in Section 220200 – EXCAVATION AND BACKFILLING FOR UNDERGROUND PIPING.

3.3 HORIZONTAL PIPING INSTALLATION

- A. Install piping in trenches according to ASTM D 2774 or ASTM D 2657 and in accordance with manufacturer's written instructions.
- B. The horizontal ditches for the ground-loop heat-pump header piping may be dug with trenching machine. The header piping shall be buried a minimum of 48" deep. Dig the trench approximately 6" deeper than required and install a base of 6" of compacted sand or #9 limestone gravel. Clean out all rocks from trench before placing piping. After the piping is installed, tested, flushed, purged, inspected, and approved, backfill with 6" of sand or #9 limestone gravel first then finish with rock free backfill material. Note: Backfill under paved areas shall be compacted dense grade from the 6" of manufactured sand to the underside of paving.

- C. The pipe and pipe fittings must be joined using the socket or butt heat fusion process. No other method is acceptable. The vertical loop take-off tee fittings may be made using the saddle fusion process on header piping 1 1/4" and above. Exercise extreme caution to completely remove the cutout material. On header piping 1" and smaller use regular tee fittings. Bell reducer fittings shall be used at all pipe reductions to eliminate trapped air.
- D. Coordinate the laying of the header piping with existing utilities, new mechanical and electrical utilities. Prepare dimensioned drawing of the complete ground-loop heat-pump piping system showing the exact location and depth of all exterior geothermal loop piping and the exact location of each geothermal well before backfilling.
- E. Install continuous detectable warning tape for underground piping. Locate tape a minimum of 24 inches below finished grade, directly over piping. Underground warning tapes are specified in Section 230553 – IDENTIFICATION OF HVAC PIPING AND EQUIPMENT.

3.4 TESTING AND CLEANING

- A. Cleanliness: During installation, trash, soil, and small animals shall be kept out of the pipe. Ends of the high-density polyethylene pipe shall be taped or capped until the pipe is joined to the circuit.
- B. Flushing the Earth-Coupling: Before connection of the plastic earth-coupling lines to the distribution manifolds, each loop shall be flushed thoroughly and left filled with clean water.
- C. Each polyethylene U-fitting assembly (loop) shall be water filled and pressure tested to 100 psi prior to installation into well bore. The complete system shall be water filled and pressure tested to 100 psi prior to backfilling to the trenches. The pressure test must be observed and approved by the Engineer before the system can be backfilled.

3.5 FLUSHING AND PURGING THE SYSTEM

- A. General: Before backfilling the trenches, all systems shall be flushed and purged of air and flow tested to ensure all portions of the heat exchanger are properly flowing. A portable temporary purging unit shall be utilized and shall consist of the following: purge pump - high volume and high head; open reservoir; filter assembly with by-pass; flow meter; pressure gage; connecting piping; and connection hoses.
- B. Using the purging unit described above flush and purge each geothermal loop heat exchanger system until free of air, dirt, and debris. A minimum velocity of 2 ft/sec. is required in all pipe sections to remove the air. This flushing and purging operation should be conducted with the water source heat pump piping isolated with shut off valves. After the geothermal loop heat exchanger is completely flushed of air and debris, open the isolation valves and permit circulation through the heat pump portion of the system until the entire system is flushed and purged.
- C. Utilizing the purging unit, conduct a pressure and flow test on the geothermal loop heat exchanger to confirm the system is free of blockage. If the flow test indicates blockage, locate the blockage systematically clamping off loops with a pinch-off tool, remove the blockage, then re-purge and conduct the pressure and flow test again until all portions of the system are flowing. The flow test must be observed and approved by the Engineer before the system can be backfilled.

END OF SECTION 23 21 13.33

SECTION 23 31 13 – DUCTWORK AND DUCTWORK INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Low Pressure Ducts
- B. Medium- and High-Pressure Ducts
- C. Fabric Ductwork
- D. Insulation
- E. Duct Lagging
- F. Duct Cleaning

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 230100 - GENERAL PROVISIONS FOR MECHANICAL WORK
- C. Section 233300 - DUCTWORK ACCESSORIES

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product data: For each type of the following:
 - a. Ductwork.
 - b. Ductwork insulations.
 - c. Ductwork Hangers.

1.4 CLOSEOUT SUBMITTALS

- A. Ductwork leak testing report. Include in operation and maintenance manuals.

1.5 REFERENCES

- A. ASHRAE - Handbook 2013 Fundamentals; Chapter 21- Duct Design.
- B. ASHRAE - Handbook 1989 HVAC Systems and Equipment; Chapter 19 - Duct Construction.
- C. ASHRAE - Surface Burning Characteristics of Building Materials.
- D. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- E. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
- F. NFPA 96 - Installation of Equipment for the removal of Smoke and Grease- Laden Vapors from Commercial Cooling Equipment.
- G. IMC - International Mechanical Code - Latest Issue
- H. SMACNA - HVAC Duct Construction Standards, Metal and Flexible.
- I. UL 181 - Factory-made Air Ducts and Connections.

1.6 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

- B. Low Pressure: Up to 2" WG positive or negative and/or velocities less than 2,000 fpm.
- C. Medium Pressure: Up to 3" WG positive or negative and/or velocities less than 2,500 fpm.

PART 2- PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. C&R Sheet Metal, Ductmate, DuctSox Corporation, Eastern Sheet Metal, Euro-Aire, Fabricair, FlexmasterUSA, KE Fibertec, Lindab, Nordfab, Prihoda, Turnkey or Hamlin.

2.2 MATERIALS

- A. General: Non-combustible or conforming to requirements for Class 1 air duct materials, or UL 181.
- B. All duct material and covering shall have a flame spread rating of 24 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84.
- C. Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock forming quality, having zinc coating of 1.25 oz. Per sq. ft. for each side in conformance with ASTM G90.
- D. Duct Schedule:
 - 1. Supply, Return, Exhaust and Outside Air Ducts connected to Fan Coil Units, Furnaces, Heat Pumps, Variable Air Volume Box (VAV box outlet to grille, register, diffuser) and Terminal Units:
 - a. Pressure Class (Low Pressure): Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 16.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
 - 2. Supply Ducts Connected to Constant-Volume and Variable-Volume Air-Handling Units (air handling unit to VAV Box inlet):
 - a. Pressure Class (Medium Pressure): Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 8.
 - d. SMACNA Leakage Class for Round and Flat Oval: 4.
 - 3. All other ducts not listed above:
 - a. Pressure Class (Low Pressure): Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 16.
 - d. SMACNA Leakage Class for Round and Flat Oval: 8.
- E. Flexible Ducts: Interlocking spiral of galvanized steel, or fabric supported on helically wound spring steel wire rated to:
 - 1. Standard: Product is to be UL 181 listed and bearing the UL label.
 - 2. Flexible Ducts – Class 1, interlocking spiral of galvanized steel or fabric, supported on helically-wound spring steel wire.
 - 3. Pressure Rating: 2 inches WG positive and 1.5 inches WG negative for low pressure ducts and 15 inches WG positive or negative for medium- and high-pressure ducts.
 - 4. Maximum length per run shall be 60".

- F. Insulated Flexible Duct:
 - 1. Standard: Product is to be UL 181 listed and bearing the UL label.
 - 2. Flexible Ducts, Insulated - Class 1, Two-Ply Vinyl Film Supported by Helically Wound, Spring-Steel Wire; Fibrous-Glass Insulation.
 - 3. Pressure Rating: 10-inch WG positive and 1.0-inch WG negative
 - 4. Maximum Air Velocity: 4000 fpm.
 - 5. Temperature Range: -10 deg F to +160 deg F.
 - 6. Insulation R-Value: R-6.
 - 7. Vapor-Barrier Film: Metalized Polyester.
 - 8. Maximum length per run shall be 60".
- G. Stainless Steel Ducts: ASTM A480/A480M, Type 304.
- H. Double-Wall Duct and Fittings
 - 1. Outer Duct to conform with SMACNA Duct Construction Standards.
 - 2. Unless otherwise noted on Drawings, outer duct shall be provided with paint-grip finish.
 - 3. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch diameter perforations, with overall open area of 23%.
 - 4. Interstitial Insulation: Fibrous-glass liner complying with ASTM C1071, NFPA 90A or NFPA 90B; and NAIMA AH124, "Fibrous Glass Duct Liner Standard".
 - a. Maximum Thermal Conductivity: 0.27 Btu x in./hr. x sq. ft. x deg F at 75 deg F mean temperature.
 - b. Install spacers that position the duct liner at uniform distance from the outer duct without compressing insulation.
 - c. Coat insulation with antimicrobial coating.
 - d. Cover insulation with polyester film complying with UL 181, Class 1.
- I. Fasteners: Rivets, bolts, or sheet metal screws.
- J. Sealant: Non-hardening, water resistant, fire resistive, compatible with mating materials; liquid used with tape, or heavy mastic.
- K. Hanger Rod: Steel, galvanized; threaded both ends, threaded one end, or continuously threaded. Stainless steel for stainless steel duct.

2.3 FABRIC DUCTWORK

- A. Description of Work:
 - 1. Extent of non-metal ductwork is indicated on drawings and by requirements of this section.
 - 2. Types of non-metal ductwork require for project include the following:
 - 3. Fabric Air Dispersion Products.
- B. Quality Assurance
 - 1. Building Codes and Standards:
 - a. Product must be reviewed and approved in accordance with the Acceptance Criteria for Fabric air Dispersion System (AC167) as drafted by ICBO Evaluation Services.

- b. Manufacturer shall All sections, including Performance Requirements, Design, Installation and Quality Control sections must be satisfied. Supplying company.
- C. Design and Quality Control
 - 1. Manufacturer must have documented support information including duct sizing, vent and office location and sizing, length and support. Parameters for design, including maximum air temperature, velocity, pressure and fabric permeability, shall be considered and documented.
 - 2. The fabric air dispersion systems must be manufactured under a quality control program with inspections by a quality control agency accredited by ICBO ES.
- D. Fabric Air Dispersion System
 - 1. Air diffusers shall be constructed of a woven fire-retardant fabric complying with the following physical characteristics:
 - a. Fabric Construction: 100% Flame Retardant
 - b. Weight: 6.75 oz./yd⁵ per ASTM D3776
 - c. Color: (Custom color selected by Owner)
 - d. Air Permeability: 2 +/-1 cfm/ft² ASTM D737, Frazier
 - e. Temperature Range: 0 degrees F to 180 degrees F
 - 2. Building Codes/ Fire Retardancy:
 - a. Systems shall comply with the 2015 International Mechanical Code (IMC).
 - b. Fabric to be considered shall be Classified by Underwriters Laboratories an Air Dispersion device in accordance with the 25/50 Flame Spread/ Smoke Developed requirements of NFPA-90A.
 - 3. Systems Fabrication Requirements
 - a. Air dispersion accomplished by linear vent and permeable fabric. Linear vent is to consist of an array of open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents. Linear vents should also be designed to minimize dusting on fabric surface.
 - b. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches to be secured to metal duct via zip screw fastener - supplied by contractor.
 - c. Inlet connection includes zipper for easy removal/maintenance.
 - d. Lengths to include required zippers as specified by manufacturer.
 - e. System to include Adjustable Flow Devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 - 0.60 in w.g. static pressure.
 - f. Fabric system shall include connectors to accommodate suspension system listed below.
 - g. Any deviation from a straight run shall be made using a gored elbow or an efficiency tee. Normal 90-degree elbows are 5 gores, and the radius of the elbow is 1.5 times the diameter.
 - 4. Design Parameters
 - a. Fabric air diffusers shall be designed for 0.5-inch water gage external static pressure.

- b. Design temperatures limited between 0-180 degrees F.
 - c. Do not use fabric diffusers in concealed locations.
 - d. Use fabric diffusers only for positive air distribution components of the mechanical ventilation system.
5. Suspension Hardware (one of following)
- a. Tension Cable: System shall be installed using a tension cable system including double strands (2 Row) of cable located 3" above the 10 and 2 o'clock locations of the fabric duct system. Hardware to include cable, eye bolts, cable clamps and turnbuckle(s) as required. System attachment shall be made using nylon snap clips spaced 24 inches. All components to be of standard galvanized steel.
 - b. Suspended H-Track: System shall include double (2 Row) runs of aluminum H-Track system located 1.5" above the 10 and 2 o'clock (2 Row) locations of the fabric duct system. Hardware to include 10' sections of track, splice connectors, track endcaps and vertical cable support kits - consisting of a length of cable with a locking stud end and Gripple quick cable connectors. Radius aluminum track must be included for all radius sections.

2.4 INSULATION

- A. Internal: Glass fiber; ASTM C1071, G21 and G22 with an NRC not less than .65, 1.5 lb./cu. ft. minimum density; smooth black matted air side surface for maximum 5000 FPM air velocity.
- B. External (choose one of the following):
 - 1. Flexible or rigid glass fiber; ASTM C1290 and C1136 all-service duct wrap; K value of .27 at 75 degrees F and a minimum installed R-value of R-6. Provide with foil scrim facing.
 - 2. Reflectix (or equal) R-6.0 insulation having two layers of aluminum foil with polyethylene bonded for strength, and two inner layers of insulated bubbles; 5/16" thick; 1.25 oz./sq. ft. Flame and smoke 25/50.
- C. Insulation material and jackets shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84.
- D. Adhesives: Waterproof fire-retardant tape.
- E. Lagging Adhesives: Fire resistive to ASTM E84, NFPA 255, UL723.
- F. Impale Anchors: Galvanized steel, 12- gage, spot welded or self-adhesive pad. No anchors shall penetrate duct walls.
- G. Joint Tape: Glass fiber cloth, open mesh.
- H. Tie Wire: Annealed steel, 16-gage.

2.5 DUCT LAGGING

- A. Description: 1 lb/sf foil-faced loaded vinyl barrier bonded to a 2"-thick scrim faced quilted absorber. Product shall be equal to Noise S.T.O.P.™ B-10 Lag/Noise S.T.O.P. QFA-9 as produced by Acoustical Surfaces, Inc.
- B. Nominal Thickness: 2"
- C. Standard Size: 54"x30' (WxL)
- D. Weight: 1.4 lb/sf

- E. "R" Factor: 8.0
- F. Flammability:
- G. Class A (or 1) per ASTM E-84
 - 1. Smoke Developed – 19.5; Flame Spread – 12.5
- H. Temperature Range: -20 deg F to +350 deg F
- I. Sound Transmission Loss – ASTM E-90 & E 423

	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	STC
NS B-10 Lag/NS QFA-9	19	20	23	33	44	53	30

2.6 DUCT HANGERS

- A. All duct hangers in direct contact with galvanized duct shall be galvanized steel.
- B. All duct hangers in direct contact with stainless steel ducts shall be stainless steel.

PART 3 - EXECUTION

3.1 LOW PRESSURE DUCTWORK

- A. Fabricate and support in complete accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible and ASHRAE handbooks latest editions, except as indicated. Provide duct material, gages, reinforcing, and sealing for operation pressures indicated.
- B. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission.
- C. Construct T's, bends, and elbows with a radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation fill.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 30 degrees.
- E. Provide easements where low pressure ductwork conflicts with piping and structure. Where easements exceed 10 percent duct area, split into two ducts maintaining original duct area.
- F. Connect flexible ducts to metal ducts with draw bands or adhesive plus sheet metal screws.
- G. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.

3.2 MEDIUM- AND HIGH-PRESSURE DUCTS

- A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible and ASHRAE handbooks, except as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide air foil turning vanes. Where acoustical lining is required, provide turning vanes of perforated metal with glass fiber insulation fill.

- C. Transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence.
- D. Fabricate continuously welded medium and high-pressure round and oval ducts fittings two gages heavier than duct gages indicated in SMACNA Standard. Joints shall be minimum 4-inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
- E. Provide standard 45-degree lateral wye takeoffs unless otherwise indicated where 90-degree conical tee connections may be used.

3.3 FABRIC AIR DISPERSION SYSTEM:

- A. Install chosen suspension system in accordance with the requirements of the manufacturer. Installation instructions shall be supplied by the manufacturer.

3.4 DUCTWORK INSTALLATION

- A. Provide engineered openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring and maintain vapor barrier where applicable.
- B. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- C. Provide residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for cleanout. Use stainless steel for ductwork exposed to view and stainless steel or galvanized steel for ducts where concealed.
- D. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- E. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.
- F. Space between duct and floor or masonry wall openings shall be sealed with fire rated caulk.
- G. Verify all field conditions before fabrication of ductwork to avoid installation conflicts. Notify Engineer of any conflict areas.
- H. Do not change the designed path of ductwork, add excessive turns or offsets, or change duct sizes without first consulting the Engineer.

3.5 INSULATION INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Exterior Insulation Application
 - 1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 - 2. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 - 3. Continue insulation with vapor barrier though penetrations.
- C. Internal Application
 - 1. Adhere insulation with adhesive for 100 percent coverage. Secure insulation with mechanical fasteners on 15-inch centers maximum on top and side of ductwork with dimension exceeding 20 inches. Seal and smooth joints. DO not use nail-

type fasteners. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.

2. Ductwork dimensions indicated are net inside dimensions required for air flow. Increase ductwork to allow for insulation thickness.

D. Insulation Schedule

1. Supply, return, and outside air ductwork shall be insulated with external insulation as noted below.
2. The first 20'-0" of all ductwork from ERU building return and supply shall be internally lined and wrapped with duct lagging as specified herein.
3. Ductwork listed below that is to be externally insulated:
 - a. All supply, return and outside air ductwork shall be externally insulated unless otherwise noted.
4. Externally insulated ductwork shall be insulated using one of the following methods:
 - a. Ductwork shall be externally insulated with Reflectix (or equal) R-6.0 insulation having two layers of aluminum foil with polyethylene bonded for strength, and two inner layers of insulated bubbles; 5/16" thick; 1.25 oz./sq. ft. Flame and smoke 25/50.
 - i) Ductwork may also be insulated with fiberglass insulation, maintaining the insulation value of R-6.0, in lieu of Reflectix insulation.
5. Insulation must be installed in strict accordance with insulation manufacturer's requirements. Provide spacers, pins, bands and adhesive as required. Special care must be taken on large ductwork to prevent sagging of insulation away from ductwork.
6. Interior exhaust duct shall not require insulation
7. Combustion air duct shall have 1½ inch external insulation.
8. Make-up air/heat recovery ductwork insulation requirements.
 - a. Building supply and/or return air duct shall have 1-inch thick minimum internal insulation on the first 15'-0' of duct from the make-up air unit including any tees and elbows for noise control. Ductwork past this point shall not require insulation.
 - b. Outside air ductwork to make-up air units shall have R-6.0 external insulation when located within the building envelope assembly.
 - c. Exhaust air ductwork from make-up air units shall not require insulation.
9. Exterior mounted ductwork shall be externally insulated with 1½ inch rigid fiberglass board insulation with a vapor retarder and thermal conductivity of 0.23 at 75 degrees mean temperature providing a minimum R-value of R-8. Board insulation shall be protected (waterproofed) by self-stick laminate or reflective aluminum foil, rugged, cross-linked polymer films, and a thick layer of rubberized asphalt tested to ASTM D1970 similar to Peel & Seal by MFM Building Products Corp. or ArmaTuff by Armacell Engineered Foams or Alumaguard by Polyguard Products, Inc. or Ideal Seal 777, by American Biltrite, Inc.
10. Where duct is scheduled to be insulated (either externally or internally) herein and shown to be routed in an area that will be exposed based on Architectural

drawings, the Contractor shall provide double-wall duct conforming with the specifications provided herein.

11. All ductwork insulation must conform to the minimum requirements of ASHRAE 90.1 (current edition) and International Energy Conservation Code (current edition) unless otherwise specified in this section.

3.6 HANGERS

- A. Duct hangers may be directly attached to ducts. Ducts shall be hung by angles or straps as listed in the following schedule. Rods, straps or angles may be used in trapeze hangers. Hangers shall be in accordance with the following schedule, except that there shall be no less than one set of hangers for each section of ductwork. Where elbows or tees are installed for changes in direction, hangers shall be provided. No ductwork shall rest on the building structural system. No ductwork shall be supported by suspended ceiling systems. All ductwork must be independently supported from building structural system.
- B. Where trapeze hangers are used, the bottom of the duct shall be supported to angle sized as follows (for round ducts, the angle shall conform to the bottom 120 degrees of the duct):

Diameter of Duct	Width of Duct	Bottom Angle Sizes
0"-32"	0"-30"	1" x 1" x 1/8"
35" and Larger	31" - 48"	1-1/2" x 1-1/2" x 1/8"

- C. All hangers shall be sufficiently across-braced to eliminate, in the opinion of the Architect, excessive sway. Wherever ductwork contains filter sections, coils, fans or other heavy equipment (excluding registers, grilles, diffusers, splitter dampers, etc.) such equipment shall be hung independently of the ductwork, with rods or angles of sizes adequate to support the load.
- D. Special Duct Hanging Conditions
 1. In the event ductwork interferes with suspended ceiling support hangers, provide cross members from hangers affected. These cross members shall be of reinforcing steel or furring channels and shall run under ductwork in question from which additional ceiling hangers shall be supported.

3.7 TESTING FOR LEAKAGE

- A. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
- B. Test the following systems:
 1. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections, selected by Engineer from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
- C. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
- D. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
- E. Test for leaks before applying external insulation.
- F. 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.

- G. Give seven days' advance notice for testing.

3.8 TESTING

- A. The test apparatus shall consist of:

1. A source of high pressure air - a portable rotary blower or a tank type vacuum cleaner.
2. A flow measuring device orifice assembly consisting of straightening vanes and an orifice plate mounted in a straight tube with properly located pressure taps. Each orifice assembly is accurately calibrated with its own calibration curve. Pressure and flow readings shall be taken with U-tube manometers or equivalent gauge.

- B. Test Procedures

1. Close off and seal all openings in the duct section to be tested. Connect the test apparatus to the duct by means of a section of flexible duct.
2. Start the blower with its control damper closed.
3. Gradually open the inlet damper until the duct pressure reaches 25 percent in excess of designed duct operating pressure indicated.
4. Survey all joints for audible leaks. Repair each leak after shutting down blower. Do not apply a retest until sealants have set.
5. If measured leakage exceeds 1 percent of total design flow, locate and seal leakage.
6. After all audible leaks have been sealed, the remaining leakage should be measured with the orifice section of the test apparatus as follows:
 - a. Start blower and open damper until pressure in duct reaches 25% in excess of designed duct operating pressure indicated.
 - b. Read the pressure differential across the orifice on manometer to determine leakage.
 - c. Total allowable leakage should not exceed one (1) percent of the total system design air flow rate. When partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.
7. Provide duct leak testing report.

END OF SECTION 23 31 13

SECTION 23 31 14 – NON-FIBROUS CLOSED CELL OUTDOOR DUCTWORK SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Section includes pre-manufactured ductwork system consisting of inner foam liner for thermal efficiency, exterior pre-coted galvanized shell for low leakage and weather resistance.
 - 1. Basis of Design: Tuff Duct
 - 2. Acceptable Manufacturers: Pro-R Duct, Thermaduct.

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 230100 - GENERAL PROVISIONS FOR MECHANICAL WORK
- C. Section 233300 – DUCTWORK ACCESSORIES

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product data: For each type of the following:
 - a. Ductwork.
 - b. Ductwork insulations.
 - c. Ductwork stands.

1.4 QUALITY ASSURANCE

- A. Provide 25-year warranty.

1.5 GENERAL

- A. Inner Liner: System shall incorporate a fortified inner liner with included testing and passing the following:
 - 1. ASTM C 423 noise reduction
 - 2. ASTM C 518: 2004, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
 - 3. ASTM C 1071 for erosion
 - 4. ASTM E 84 tested, Tunnel Test, Does not exceed 25 flame spread, 50 smoke developed.
 - 5. ASTM E 96/E 96M Procedure A for permeability
 - 6. ASTM E2257 Standard Test Method for Room Fire Test of Wall and Ceiling Materials and Assemblies
 - 7. NFPA Compliance:
 - a. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems"
 - b. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems"

- c. NFPA 255, "Standard Method of Test of Surface Burning Characteristics of Building Materials
 - 8. NRTL product approval, (Subpart S of 29 CFR Part 1910, OSHA)
 - 9. UL 181 Standard for Factory-Made Air Ducts and Air Connectors
 - 10. UL 723 Test for Surface Burning Characteristics of Building Materials
 - B. Exterior Shell: System shall incorporate a UV stable, pre-coated galvanized exterior shell.
 - 1. .20-.30 mill primer baked on finish.
 - 2. .70-.80 mill polyester topcoat
- 1.6 DUCTWORK CLASSIFICATION
- A. Duct systems are to be classified and constructed per the SMACNA Velocity-Pressure classification system as follows:

PART 2 - PRODUCTS

2.1 RECTANGULAR DUCTWORK AND FITTINGS

- A. The inner liner panel shall be manufactured of CFC-free closed cell rigid thermoset resin thermally bonded on both sides to a factory applied minimum 0.001" (25 micron) aluminum foil facing reinforced with a fiberglass scrim. The outer panel shall be a per-coated galvanized sheet metal jacket, with a .20-.30 mil primer baked on finish with a .70-.80 mill polyester UV stable top coat.
- B. Materials:
 - 1. The density of the inner foam liner shall not be less than 3.43 pcf (55 Kg/m3) with a minimum compressive strength of 28 psi.
 - 2. Maximum Temperature: Continuous rating of 185 degF to -15 degF inside ducts or ambient temperature surrounding ducts.
 - 3. Maximum Thermal Conductivity: 0.146 Btu-in./h-sqft. -degF at 75 degF mean temperature.
 - 4. Antimicrobial Agent: Additive for antimicrobial shall not be used but instead, raw product must pass UL bacteria growth testing.
 - 5. Required Markings: All interior duct liner shall bear a UL label and other markings required by UL 181 on each full sheet of duct panel.
 - 6. All insulation materials shall be closed cell with a closed cell content of >90%.
 - 7. Internal Tape: 3M high temperature, high strength, UL181A-P foil tape with coated cold weather acrylic adhesive.
 - 8. Outer Sealant: Novagard, NovaFlex Metal Roof Adhesive Sealant.
 - 9. Outer Jacket: galvanized steel pre-coated with a UV stable 20-.30 mil primer baked on finish with a .70-.80 mill polyester topcoat.
 - a. Standard white finish with custom colors available
 - 10. Duct Connections: TDC (SMACNA Figure 2-1, Page 2.9, T-25a)
 - 11. Connection Cover: Tuff Cap
 - a. Connection are field sealed airtight before the cover is installed.
 - b. Tuff Cap Connection covers and corners are manufactured using high-impact PVC with UV stabilizers added for sun protection.

PART 3 – EXECUTION

3.1 FABRICATION

- A. Certification:
- B. All fabrication labor will be certified “yellow label” building trade professionals, compliant to SMACNA labor guidelines.
- C. Fabrication:
 - 1. Pre-fabricated joints, seams, transitions, taps, elbows, tees, and access doors according to Manufacturer’s instructions.
 - 2. Pre-fabricated radius heel 45-degree throat elbow (SMACNA Figure 4-2, page 4.4).
 - 3. Pre-fabricated ductwork shall include 5 inches of straight on the end of each connecting piece, leaving room to install the connection cover.
 - 4. Fabricated duct segments utilizing internal and external sealed Pittsburgh seams. Internal seams will be sealed with VOC silicone. Each duct segment will be factory supplied with either 4-bolt TDC or slip-on flange in accordance with manufacturer’s submittal package.
 - 5. Applied internal and external duct reinforcement to prevent swelling and narrowing of duct based on positive and negative pressure guidelines provided by the manufacturer.
 - 6. Designed and fabricated duct segments and fittings will be in compliance with latest edition SMACNA HVAC Duct Construction Standards.
 - 7. Both positive and negative ductwork and fittings shall be constructed to incorporate a UL Listed – Class 1 air duct to Standard for Safety UL 181 liner with an exterior pre-coated galvanized shell—with options for aluminum and stainless—for permanent protection against water intrusion.
 - 8. Duct shall be constructed to exceed requirements for rain, snow and wind load.

3.2 DUCT INSTALLATION

- A. Duct segments shall be installed per the Tuff Duct Installation Instructions provided by the Manufacturer.
- B. Duct air leakage to comply with the latest version of “SMACNA HVAC Air Duct Leakage Test Manual” in accordance with the applicable pressure class.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Contractor to ensure ductwork is properly and adequately supported per the SMACNA HVAC Duct Construction Standards.
- B. Supports on straight runs of ductwork shall be spaced 6-8 feet apart and shall not exceed 12 feet in spacing.
- C. Ductwork shall be supported at changes of direction, branch connection pieces, tees, parallel to elbow turning vanes and duct accessories.

3.4 FIELD QUALITY CONTROL

- A. 25-year warranty activation: Installing contractor will provide Hranec Sheet Metal with acknowledgement and documentation that they have fully complied with the Tuff Duct Installation Instructions.

3.5 DUCT SCHEDULE

- A. Exterior Duct and Fittings:

1. Tuff Duct Rectangular
 - a. Minimum Panel Thickness: 22 mm
 - b. Galvanized Steel Outer Shell: 0.0336 inch
 - c. Duct Liner: R8.0 / 1.5 pcf insulation.

END OF SECTION 23 31 14

SECTION 23 33 00 – DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Volume Control Dampers
- B. Fire Dampers
- C. Backdraft Dampers
- D. Air Turning Devices
- E. Flexible Duct Connectors
- F. Duct Access Doors
- G. Duct Test Holes

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 230100 - General Provisions for Mechanical Work
- C. Section 233113 - Ductwork and Ductwork Insulation

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product specified.

PART 2 - PRODUCTS

2.1 VOLUME CONTROL DAMPERS

- A. Acceptable Manufacturers
 - 1. United Enertech, Air Balance, American Warming, Arrow, Cesco, Creative Metals, Nailor, Pottorff, Ruskin, Vent Products, and Whiz Air.
- B. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards, and as indicated.
- C. Fabricate splitter dampers of material same gage as duct to 24 inches size in either direction and two gages heavier for sizes over 24 inches.
- D. Fabricate splitter dampers to streamline shape. Secure blade with continuous hinge or rod. Operate with minimum 1/4-inch diameter rod in self-aligning, universal joint action flanged bushing with set screw.
- E. Fabricate single blade dampers for duct sizes to 12 inch.
- F. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12 x 72 inches. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- G. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
- H. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Where rod lengths exceed 30 inches provide regulator at both ends.

- I. All dampers shall be provided with a continuous, single-piece shaft, welded to damper face. Multiple-piece or V-shaped shafts are not acceptable.
- J. Where ductwork is required to have external insulation wrap applied, dampers shall be provided with 2" stand-off (minimum) to allow full range of motion of damper handle without damage to surrounding insulation.

2.2 FIRE DAMPERS

- A. Acceptable Manufacturers
 - 1. United Enertech, Air Balance, Arrow, Cesco, Greenheck, Metalaire, Pottorff, Prefco, Ruskin, and Vent Products.
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated. Provide dynamic type damper unless otherwise specified as static.
- C. Fabricate ceiling firestop flaps of galvanized steel, 22 gage frame and 16 gage flap, two layers 0.125-inch ceramic fiber on top side, and one layer on bottom side for round flaps, with locking clip.
- D. Fabricate ceiling dampers of galvanized steel, 22 gage frame, stainless steel closure spring, and light weight, heat retardant non-asbestos fabric blanket closure.
- E. Fabricate curtain type dampers of galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream.
- F. Fabricate multiple blade fire dampers with 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless-steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock. Fire dampers shall have UL rating.
- G. Fusible links, UL 33, shall separate at 160 degrees F. Provide adjustable link straps for combination fire/balancing dampers.

2.3 BACKDRAFT DAMPERS

- A. Acceptable Manufacturers
 - 1. United Enertech, Air Balance, Arrow, Cesco, Nailor, Pottorff, Ruskin, and Vent Products.
- B. Gravity backdraft dampers, size 18 x 18 inches or smaller, furnished with air moving equipment, may be air moving equipment manufacturers standard construction.
- C. Fabricate multi-blade, parallel action gravity balanced backdraft dampers of 16 gage galvanized steel, with center pivoted blades of maximum 6-inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.4 AIR TURNING DEVICES

- A. Acceptable Manufacturers
 - 1. Ductmate Industries, Duro-Dyne, Metalaire, Semco, Ward Industries.
- B. Multi-blade device with blades aligned in short dimension; steel or aluminum construction; with individually adjustable blades, mounting straps. Provide in all square turns.

2.5 FLEXIBLE DUCT CONNECTORS

- A. Acceptable Manufacturers

1. Ductmate Industries, Duro-Dyne, Vent Fabrics, Ward Industries.
- B. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards, and as indicated.
- C. UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 20 oz per square yard, approximately 6 inches wide, crimped into metal edging strip.

2.6 DUCT ACCESS DOORS

- A. Acceptable Manufacturers
 1. American Warming, Cesco, Ductmate Industries, Kees, Pottorff, Safe Air/Dowco, Vent Fabrics
- B. Fabricate in accordance with SMACNA Low Pressure Duct Construction Standards and as indicated.
- C. Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum one-inch thick insulation with sheet metal cover.
- D. Access doors smaller than 12 inches square may be secured with sash locks.
- E. Provide two hinges and two sash locks for sizes up to 18 inches square, three hinges and two compression latches with outside and inside handles for sizes up to 24 x 48 inches. Provide an additional hinge for larger sizes.
- F. Access doors with sheet metal screw fasteners are not acceptable.
- G. Fire and Smoke Damper Access: Ductwork serving dampers 12"x12" and 12" diameter inside clear dimension and smaller, Rectangular and round, to be provided with a removable ductwork section for damper inspection and maintenance. Removable ductwork section to function without the use of tools.

2.7 DUCT TEST HOLES

- A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- B. Permanent test holes shall be factory fabricated, airtight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.8 REMOVABLE DUCT SECTIONS

- A. Rectangular Ductwork:
 1. Manufacture rectangular access section suitable for duct pressure class. Clamping-type removable ductwork section with draw latch. Access section shall be manufactured to maintain 100 percent of ductwork free area.
 2. Allowable leakage: ½ CFM per 100 square feet of ductwork surface area at 2" W.G.
 3. Provide size as indicated on drawing. Maximum size is 18"x18".
 4. Material: Galvanized ASTM A527.
 5. Flange connection: 18 Gauge galvanized sheet metal construction.
 6. Seams: Pittsburgh lock. Access Section: Minimum 26-gauge galvanized ASTM A527 12" long.
 7. Clamps: 20 Gauge galvanized with zinc coated draw latch. Gasket profile forms to the inside of clamp and seals the outer edges of the ductwork flanges.

8. Gasket: Neoprene gasket 3/16" x 1 1/4". Seal seams in accordance with SMACNA HVAC Duct Construction Standard- Metal and Flexible.
 9. Liner (Required for insulated duct system): 1/2" Armaflex internally lined. Top surface even and on the same plane with adjoining ductwork.
 10. Approved manufacturers: Langdon, Inc. or approved equal.
- B. Round Ductwork:
1. Manufacture round access section suitable for duct pressure class. Clamping type removable ductwork section with draw latch. Access section shall be manufactured to maintain 100 percent of ductwork free area.
 2. Allowable leakage: 1/2 CFM per 100 square feet of ductwork surface area at 2" W.G.
 3. Provide size as indicated on drawing. Maximum size is 22" diameter.
 4. Material: Galvanized ASTM A527.
 5. Flange connection: 90 Degree continuous machine formed flange, provide extended flanges if specified.
 6. Seams: (RL-3) Lap and spot weld on 2" interval.
 7. Access section: Galvanized sheet metal construction 12" long, 22 Gauge 4" to 12" diameter, 20 Gauge 13" to 22" diameter 12" long.
 8. Clamps: 20 Gauge galvanized with zinc coated draw latch and self-centering flange guides. Gasket profile forms to the inside of clamp and seals the outer edges of the ductwork flanges.
 9. Gasket: Red silicone sponge gasket. Temperature range 40°F to 400°F. Seal seams in accordance with SMACNS HVAC Duct Construction Standards – Metal and Flexible.
 10. Liner (Required for insulated duct systems): 1/2" Armaflex internally lined. Top surface even and on the same plane with adjoining ductwork.
 11. Approved manufacturer: Langdon, Inc. or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions.
- B. Provide balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Use splitter dampers where required.
- C. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- D. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.
- E. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated. Provide minimum 8 x 8-inch size for hand access, 18 x 18-inch size for shoulder access, and as indicated.
- F. Provide duct test holes where indicated and required for testing and balancing purposes.
- G. Provide fire dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with

required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

- H. Only dynamic fire dampers are to be used unless otherwise specified. Dynamic fire dampers are specifically to be used where heating, ventilating and air conditioning systems are designed to operate with fans on during a fire.
- I. Demonstrate re-setting of fire dampers to authorities having jurisdiction and Owner's representative.

END OF SECTION 23 33 00

SECTION 23 34 23 – POWER VENTILATORS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Roof Exhaust Fans
- B. Sidewall Exhaust Fans
- C. Inline Exhaust Fans
- D. Ceiling Exhaust Fans
- E. Wall Propeller Fans

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 230100 - GENERAL PROVISIONS FOR MECHANICAL WORK
- C. Section 230529 - SUPPORTS AND ANCHORS FOR HVAC PIPING AND EQUIPMENT
- D. Section 230548 - VIBRATION ISOLATION FOR HVAC EQUIPMENT AND PIPING
- E. Section 233113 - DUCTWORK AND DUCTWORK INSULATION
- F. Section 230900 - INSTRUMENTATION AND CONTROLS FOR HVAC

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product indicated.
 - a. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
 - b. Rated capacities, operating characteristics, and furnished specialties and accessories.
 - c. Certified fan performance curves with system operating conditions indicated.
 - d. Certified fan sound-power ratings.
 - e. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - f. Material thickness and finishes, including color charts.
 - g. Dampers, including housings, linkages, and operators.
 - h. Prefabricated roof curbs.
 - i. Fan speed controllers.
 - j. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Approved Shop Drawings: For all fans and related components. Provide in operation and maintenance manual.

- B. Operation and Maintenance Data: For fans to include in operation, and maintenance manuals.

1.5 REFERENCES

- A. AMCA 99 - Standards Handbook.
- B. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
- C. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
- D. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.
- E. SMACNA - Low Pressure Duct Construction Standard.

1.6 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210.
- B. Sound Ratings: AMCA 301, tested to AMCA 300.
- C. Fabrication: Conform to AMCA 99.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Acme Engineering & Manufacturing Corp.
 - 2. Aerovent; a division of Twin City Fan Companies, Ltd.
 - 3. Carnes Company.
 - 4. CaptiveAire.
 - 5. Greenheck Fan Corporation.
 - 6. JencoFan.
 - 7. Loren Cook Company.
 - 8. PennBarry.
 - 9. S & P USA Ventilation Systems, LLC.

2.2 GENERAL

- A. Provide all fans with disconnect.
- B. Provide all fans with motor starters. See Section 230100 for details.
- C. Integral phase relay shall be provided as a part of all three phase motor starters. Relay shall shut motor down on phase loss or phase unbalance and automatically reset when normal phasing is restored. Phase failure relay shall have adjustable restart time capabilities. Mechanical contractor shall coordinate staggered restart times as required.
- D. See drawings or Specification Section 230900 – INSTRUMENTATION AND CONTROLS FOR HVAC for control of fans.

2.3 ROOF EXHAUST FAN

- A. Roof exhaust fans shall be of the centrifugal, belt or direct driven type as specified. The fan housing shall be constructed of heavy gauge aluminum mounted on a rigid support structure. The shroud shall have a rolled bead and internal structural members. The fan wheel shall be of the aluminum backward curved, centrifugal type with inlet venturi for maximum performance. Wheels shall be dynamically and statically balanced. Motors and centrifugal wheels shall be mounted on vibration isolators.

- B. Motors shall be isolated from the exhaust airstream. Air for cooling the motor shall be taken into the motor compartment from a location free from contaminants. Motors shall be readily accessible for maintenance.
- C. A disconnect switch shall be factory installed and wired from the fan motor to the disconnect junction box. A conduit chase shall be provided for running electrical wiring through the curb cap into the power compartment.
- D. All fans shall bear the AMCA Certified Ratings Performance Seal for both air and sound performance.
- E. Provide with gravity back draft dampers.
- F. Provide factory roof curb to match the slope of the roof, minimum 12-inch height.

2.4 SIDEWALL EXHAUST FAN

- A. Sidewall exhaust fans shall be of the centrifugal, belt or direct driven type as specified. The fan housing shall be constructed of heavy gauge aluminum with a one-piece wind band with a rolled bead and internal structural members. The fan wheel shall be of the aluminum backward curved, centrifugal type with inlet venturi for maximum performance. Wheels shall be dynamically and statically balanced. Motors and centrifugal wheels shall be mounted on vibration isolators.
- B. Motors shall be isolated from the exhaust airstream. Air for cooling the motor shall be taken into the motor compartment from a location free from contaminants. Motors shall be readily accessible for maintenance.
- C. A disconnect switch shall be factory installed and wired from the fan motor to the disconnect junction box. A conduit chase shall be provided for running electrical wiring through the mounting cap into the power compartment.
- D. All fans shall bear the AMCA Certified Ratings Performance Seal for both air and sound performance.
- E. Provide with gravity back draft dampers.

2.5 INLINE EXHAUST FAN

- A. Duct mounted, exhaust fans shall be of the centrifugal belt or direct driven in-line type as specified. The fan housing shall be of the square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars.
- B. Fan housing shall be equipped with a hinge able service door assembly supporting the motor, drives, wheel and inlet cone. The door assembly must swing out for cleaning, inspection or service without dismantling the fan in any way.
- C. The fan wheel shall be of the aluminum backward inclined, centrifugal type. Wheels shall be dynamically and statically balanced and shall overlap the spun inlet venturi for maximum performance.
- D. The motor and drives shall be isolated from the air stream. Motors shall be of the heavy-duty type with permanently lubricated, sealed ball bearings. The wheel shaft shall be ground, and polished shafting mounted in heavy duty permanently sealed pillow block bearings. Drives shall be sized for a minimum of 165% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. The motor pulleys shall be adjustable for final system balancing.
- E. Flexible wiring leads shall be provided from the fan motor to an external mounted junction box and disconnect switch permitting access for service without disconnecting the field wiring.
- F. All fans shall bear the AMCA Certified Ratings Seal for both air and sound performance.

2.6 CEILING EXHAUST FANS

- A. Centrifugal Fan Unit: V-belt or direct drive as specified, with galvanized steel housing lined with 1/2-inch acoustic insulation resilient mounted motor, gravity backdraft damper in discharge.
- B. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor and wall mounted multiple speed switch/solid state speed controller.
- C. Grille: Molded white plastic or aluminum with baked white enamel finish.
- D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed, variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position, fan shaft with self-aligning pre-lubricated ball bearings.

2.7 WALL PROPELLER FANS

- A. All sidewall fans shall be axial type which meet specified sound power ratings.
- B. Propellers shall be constructed of die formed steel blades continuously welded to a convex hub. A standard square key and set screws or tapered bushings shall securely lock the propeller to the shaft. Propellers shall be statically and dynamically balanced.
- C. Motors shall be of the heavy-duty ball bearing type matched to the fan load and furnished at the specified voltage, phase and enclosure. Motors shall be totally enclosed, fan cooled.
- D. Ground and polished steel fan shafts shall be mounted in permanently lubricated, sealed ball bearing pillow blocks. Drives shall be sized for a minimum of 150% of driven horsepower.
- E. Drive frame assemblies shall be formed steel construction. The fan panel shall have prepunched mounting holes, formed flanges and a deep formed inlet venturi. All structural components shall be coated for a long-lasting finish.
- F. The fans shall bear the AMCA certified ratings seal for both air and sound performance.
- G. Provide with factory mounted and wired disconnect.
- H. Provide gravity or motorized back draft damper on exhaust fans as specified.

PART 3- EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install equipment in a manner to provide required clearances for proper operation and maintenance.
- C. For roof mounted fans, secure roof exhausters with lag screws to roof curb.

END OF SECTION 23 34 23

SECTION 23 36 00 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Shutoff, single-duct air terminal units.
 - 2. Casing liner.

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 233113 - DUCTWORK
- C. Section 233300 - DUCTWORK ACCESSORIES
- D. Section 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of air terminal unit.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
 - b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - c. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - d. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Approved Shop Drawings: For all fans and related components. Provide in operation and maintenance manual.
- B. Operation and Maintenance Data: For fans to include in operation, and maintenance manuals.

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.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- C. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 ACCEPTABLE MANUFACTURERS

- A. Trane, ETI, Nailor, Kreuger, Price, Titus.

2.3 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS

- A. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- B. Casing: 0.034-inch thick galvanized steel, single wall.
 - 1. Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
 - 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 - 3. Air Outlet: S-slip and drive connections.
 - 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
 - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from zero to 140 deg F, shall be impervious to moisture and fungus, shall be suitable for 10-inch wg static pressure, and shall be factory tested for leaks.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 - 1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.
- E. Electric Heating Coils: Electric heating coils shall consist of open coils of high grade nickel and chromium resistance wire or nichrome elements and insulated with ceramic insulators in galvanized steel brackets, supported in heavy gauge galvanized steel frames with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware. Each unit employing an electric heating coil shall be constructed and installed in accordance with the requirements of the local authorities and shall be UL or ETL listed specifically with the heater as a component of the terminal unit device.
 - 1. Electric coils shall be provided with SCR control.
- F. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
 - 1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
 - 2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
 - 3. Disconnect Switch: Factory-mounted, fuse type.
- G. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.
- H. Control devices shall be compatible with temperature controls system specified in Section 230900 Instrumentation and Controls for HVAC.

2.4 CASING LINER

- A. Casing Liner: Fibrous-glass with foil facing duct liner, complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Minimum Thickness: 3/4 inch.
 - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
- B. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
- C. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 Supports and Anchors for HVAC Piping and Equipment.

3.2 TERMINAL UNIT INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.
- D. Hot-Water Piping: Comply with requirements in Section 232113 Hydronic Piping & Valves and Section 232116 Hydronic Piping Specialties, and connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- E. Comply with requirements in Section 233113 Ductwork and Ductwork Insulation for connecting ducts to air terminal units.
- F. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 Ductwork Accessories.
- G. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 Identification for HVAC Piping and Equipment for equipment labels and warning signs and labels.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
 2. Leak Test: After installation, fill water coils 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.
- B. Air terminal unit will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 36 00

SECTION 23 37 13 – AIR DISTRIBUTION DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Diffusers
- B. Registers/grilles
- C. Louvers
- D. Spun Aluminum Relief Gravity Ventilators

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 230100 - GENERAL PROVISIONS FOR MECHANICAL WORK
- C. Section 233113 - DUCTWORK AND DUCTWORK INSULATION
- D. Section 233300 - DUCTWORK ACCESSORIES

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product indicated.
 - a. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop, and noise ratings.
 - b. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 REFERENCES

- A. ADC 1062 - Certification, Rating and Test Manual.
- B. AMCA 500 - Test Method for Louvers, Dampers and Shutters.
- C. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- D. ARI 650 - Air Outlets and Inlets.
- E. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.
- F. SMACNA - Low Pressure Duct Construction Standard.

1.5 QUALITY ASSURANCE

- A. Test and rate performance of air outlets and inlets in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.
- B. Test and rate performance of louvers in accordance with AMCA 500.

1.6 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer listed in schedule is for design selection only.
 - B. Registers, Grilles, and Diffusers
 - 1. Anemostat, Carnes, Hart and Cooley, Krueger, Metalaire, Price, Titus, Tuttle and Bailey.
 - C. Louvers
 - 1. Arrow, Cesco, Greenheck, Louvers and Dampers, Ruskin, Vent Products and United Enertech, Pottorff.
 - D. Spun Aluminum Relief Gravity Ventilators
 - 1. Greenheck, Loren Cook, Ruskin and United Enertech.
- 2.2 RECTANGULAR CEILING DIFFUSERS
- A. Square, stamped, multicore type diffuser to discharge air in fixed 360-degree pattern, or adjustable pattern as specified.
 - B. Provide for surface mount and inverted T-bar where shown. In plaster ceilings, provide plaster frame and ceiling frame.
 - C. Fabricate of aluminum with baked enamel finish.
 - D. Provide radial opposed blades damper adjustable from diffuser face for surface mounted unit where specified.
- 2.3 CEILING GRID CORE EXHAUST AND RETURN REGISTERS/GRILLES
- A. Fixed grilles of 1/2 x 1/2 x 1-inch louvers.
 - B. Fabricate margin frame with countersunk screw mounting or lay-in frame for suspended grid ceilings as shown in schedule on drawings.
 - C. Fabricate of aluminum with factory clear lacquer finish.
 - D. Where scheduled provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.
 - E. All louver-faced grilles shall be provided with pattern controller blades unless scheduled otherwise on the Drawings.
- 2.4 WALL SUPPLY REGISTERS/GRILLES
- A. Streamlined and individually adjustable blades, depth of which exceeds 3/4 inch with adjustable blades, vertical, horizontal face, and horizontal rear deflectors.
 - B. Fabricate margin frame with countersunk screw or concealed mounting and gasket suitable for surface or duct mounting.
 - C. Fabricate of steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory baked enamel finish.
 - D. Provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.
- 2.5 WALL EXHAUST AND RETURN REGISTERS/GRILLES
- A. Streamlined blades, fixed, non-adjustable, horizontal face.
 - B. Fabricate margin frame with countersunk screw or concealed mounting.
 - C. Fabricate of steel with 20 gage minimum frames and 22 gage minimum blades, steel and aluminum with 20 gage minimum frame, or aluminum extrusions, with factory baked enamel finish.

2.6 LOUVERS

- A. Provide louvers with blades on 37.5- or 45-degree slope, heavy channel frame, bird screen with 1/2 inch square mesh for exhaust and 3/4 inch for intake.
- B. Fabricate of extruded aluminum, welded assembly with factory baked-enamel finish.
- C. Furnish with required flange to match installation required.

2.7 SPUN ALUMINUM RELIEF GRAVITY VENTILATOR - GREENHECK MODEL GRSR

- A. General Description:
 - 1. Ventilator is low silhouette for relief applications with natural gravity or negative pressure system
 - 2. Selection based on non-ducted applications
 - 3. Intake unit sizes 8 to 48
 - 4. Performance capability up to 18,200 cubic feet per minute (cfm)
 - 5. Each unit shall bear a permanently affixed manufacture's nameplate containing the model number and individual serial number
- B. Hood:
 - 1. Constructed of aluminum
 - 2. Internal structure is constructed of galvanized steel
- C. Housing:
 - 1. Curb Cap type: Not Hinged
 - 2. Constructed of aluminum, includes windband and curb cap. Galvanized material is not acceptable
 - 3. Windband to be one piece spun aluminum construction and maintain original material thickness throughout the housing.
 - 4. Windband to include an integral rolled bead for strength
 - 5. Curb cap to have integral deep spun inlet venturi and pre-punched mounting holes to ensure correct attachment to roof.
- D. Options/Accessories:
 - 1. Curb Seal:
 - a. Rubber seal between fan and the roof curb
 - 2. Roof Curbs:
 - a. Type: GPI – Welded, straight sided curb with 2 inches of flashing flange and wood nailer.
 - b. Mounted onto roof with fan
 - c. Material: Aluminum
 - d. Insulation thickness: 1.5 inches
 - e. Coating Type: Baked Enamel
 - 3. Dampers:
 - a. Type: Gravity
 - b. Prevents outside air from entering back into the building when fan is off.

- c. Balanced for minimal resistance to flow.
 - d. Galvanized frames with pre-punched mounting holes
- 4. Finishes:
 - a. Type: Baked Enamel. Architect to select color.
 - b. Flashing Flange:
 - c. Constructed of aluminum
 - d. Pre-punched holes for installation without a roof curb
- 5. Bird Screen:
 - a. Construct of aluminum with 1/2" opening sizes
 - b. Fitted to the top of the throat and prevents entry of small animals.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Furnish and install where shown on drawings all registers, grilles, diffusers and louvers in accordance with the tabulation in the schedule on drawings.
- B. Provide accessories and modifications as indicated in schedule notes.
- C. Install items in accordance with manufacturer's instructions.
- D. Install in locations as shown on drawings. Items have been located as shown to provide maximum performance. Coordinate with architectural features and notify Architect/Engineer of any conflicts.
- E. Install diffusers to ductwork with airtight connection.
- F. Provide accessible balancing dampers on duct take-off to diffusers, and grilles and registers, regardless of whether dampers are specified as part of the diffuser, or grille and register.

END OF SECTION 23 37 13

SECTION 23 74 13 – PACKAGED ROOF TOP GAS/ELECTRIC AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Packaged roof top unit
- B. Unit controls
- C. Roof mounting frame and base

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISION FOR MECHANICAL WORK

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product indicated.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes, and related roof curb.
 - b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - c. Include unit dimensions and weight.
 - d. Include cabinet material, metal thickness, finishes, insulation, and accessories.
 - e. Include certified fan-performance curves with system operating conditions indicated.
 - f. Include certified coil-performance ratings with system operating conditions indicated.
 - g. Include filters with performance characteristics.
 - h. Include dampers, including housings, linkages, and operators.
 - i. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Approved Shop Drawings: For all roof top units and related components. Provide in operation and maintenance manual.
- B. Operation and Maintenance Data: For roof top units to include in operation and maintenance manuals.

1.5 WARRANTY

- A. Provide one (1) year manufacturer's warranty on unit.
- B. Include four (4) year extended coverage of refrigeration compressors.

1.6 EXTRA MATERIALS

- A. Provide one (1) extra set of filters for each unit.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

- A. Trane, Carrier, McQuay, York.

2.2 MANUFACTURED UNITS

- A. Provide roof-mounted units having electric refrigeration.
- B. Unit shall be self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, controls, air filters, refrigerant cooling coil and compressor, condenser coil, condenser fan, and natural gas-fired burner section.

2.3 FABRICATION

- A. Cabinet: Galvanized steel with baked enamel finish, access doors or removable access panels with quick fasteners. Structural members shall be minimum 14 gage with access doors or removable panels of minimum 18 gage.
- B. Insulation: One inch (1") thick neoprene coated glass fiber on surfaces where conditioned air is handled. Protect edges from erosion.
- C. Supply Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, adjustable variable pitch motor pulley and rubber isolated hinge mounted motor. Isolate complete fan assembly.
- D. Air Filters: Two inch (2") thick glass fiber disposable filters, Farr Model 30/30 or equal. New filters shall be installed at substantial completion in addition to the extra set of filters provided.
- E. Roof Curb: Insulated, weatherproof twelve inches (12") high galvanized steel, channel frame with gaskets, nailer strips and integral spring isolators. Fabricate curb to match unit requirements and fit slope of roof. See Section 220548.

2.4 EVAPORATOR COIL

- A. Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.
- B. Provide thermostatic expansion valves and alternate row circuiting.

2.5 COMPRESSOR

- A. Provide hermetic compressor, 1750 rpm resiliently mounted with positive lubrication, crankcase heater-, high- and low-pressure safety controls, motor overload protection, suction and discharge service valves and gage ports and filter drier.
- B. Provide step capacity control by cycling compressors and cylinder unloading where scheduled.

2.6 CONDENSER

- A. Provide copper tube aluminum fin coil assembly with subcooling rows.
- B. Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor.

2.7 SUPPLY/RETURN CASING

- A. Dampers Economizer: Provide low leakage outside, return and relief dampers, not to exceed 3% leakage at 1 in. w.g. pressure differential with damper operator and control package to automatically vary outside air quantity. Outside air damper shall fall to closed position. Relief dampers may be gravity balanced.
- B. Gaskets: Provide tight fitting dampers with edge gaskets, maximum leakage 3% at pressure differential.

2.8 OPERATING CONTROLS

- A. Time Delay Relay shall provide a four-minute time delay between starting of the first and second compressor.
- B. Antishort Cycle: A lockout time shall provide a minimum off time of five minutes between compressor cycling.
- C. Automatically modulating outdoor and return air dampers maintain proper room temperature into the conditioned space. Adjustable minimum position control shall be standard. Spring return motor, upon loss of power, dampers will close shut. Economizers shall offer the energy saving low-leak economizer dampers. These dampers shall reduce damper leakage down to 10 CFM/FT at 1" Wg differential static pressure or less than 1% of nominal unit air flow according to The Air Movement and Control Association (AMCA) Laboratories in accordance with AMCA Standard 575.
- D. Central Control Panel: Provide combined standard thermostat subbase with heat, cool, off, fan-auto-and-on position with 3 stages of cooling and 1 stage of heating. Four signal lights indicate power, pilot outage, clogged filters and reset relay. Power signals shows green indicating power available to unit. Power signals show red indicating power outage. Pilot signal shows red when there is a heating malfunction. Filter signal shall show red when filters clog and need replacement. Reset signals shall show red if system is out on any cooling safety controls. Economizer shall provide first stage of cooling.
- E. Control cooling by cycling compressors and cylinder unloading.

2.9 GAS HEATING SECTION

- A. Induced-draft combustion type with energy saving direct-spark ignition system and redundant main gas valve.
- B. The heat exchanger shall be of the tubular-section type constructed of a minimum of 20-gauge steel coated with a nominal 1.2 mil aluminum-silicone alloy for corrosion resistance.
- C. Burners shall be of the in-shot type constructed of aluminum-coated steel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Mount units on factory-built roof mounting frame providing watertight enclosure to protect ductwork and utility services. Install roof mounting frame level.
- C. Install units in a manner to provide the required clearances for operation, service, and maintenance of units.

3.2 DEMONSTRATION

- A. Provide Owner's maintenance personnel training as required to adjust, operate, and maintain units.

END OF SECTION 23 74 13

SECTION 23 81 26 – SPLIT SYSTEM AIR CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes split-system air-conditioning and/or heat-pump units consisting of separate evaporator-fan and compressor-condenser components and refrigerant piping and controls.

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 220100 - GENERAL PROVISIONS FOR MECHANICAL WORK
- C. See drawings for further conditions, requirements, and schedules.

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product indicated.
 - a. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
 - b. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - c. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Approved Shop Drawings: For all split system air-conditioning units and related components. Provide in operation and maintenance manual.
- B. Operation and Maintenance Data: For split system air-conditioning units to include in operation and maintenance manuals.

1.5 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. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressor: Five years from date of Substantial Completion.
 - b. For Parts: One year from date of Substantial Completion.
 - c. For Labor: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Trane, Carrier, Daikin, York, Lennox, Rheem.

2.2 INDOOR UNITS

- A. Evaporator-Fan Components:
 - 1. Airflow: Up-Flow/Horizontal/Multi-position
 - 2. Chassis: Pre-painted enamel heavy gauge galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
 - 3. Insulation: Faced, glass-fiber duct liner.
 - 4. Condensate Drain Pans:
 - a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - b. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - c. Pan-Top Surface Coating: Asphaltic waterproofing compound.
 - 5. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
 - 6. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
 - 7. Direct Drive Fan:
 - a. Statically and dynamically balanced before installation.
 - b. Resiliently mounted motor.
 - c. Easily removable for service.
 - d. Time delay fan relay.
 - 8. Fan Motors:

- a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements.
 - b. Multi-tapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Permanently lubricated, ball-bearing motors with built-in thermal-overload protection.
 - d. Wiring Terminations: Connect motor to chassis wiring with plug connection
9. Air Filtration Section:
- a. General Requirements for Air Filtration Section:
 - 1) Comply with NFPA 90A.
 - 2) Minimum MERV according to ASHRAE 52.2.
 - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
 - b. Disposable Panel Filters:
 - 1) Factory-fabricated, viscous-coated, flat-panel type.
 - 2) Thickness: 1 inch.
10. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.

2.3 OUTDOOR UNITS

- A. Air-Cooled, Compressor-Condenser Components:
- 1. Casing: Steel, finished with baked enamel in color, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing. Provide coil protection panels.
 - 2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant: R-410A.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
 - 3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
 - 4. Fan: Aluminum-propeller type, directly connected to motor.
 - 5. Motor: Permanently lubricated, with integral thermal-overload protection.
 - 6. High- and Low-Pressure switches.
 - 7. High-capacity liquid air drier.
 - 8. Low Ambient Kit: Permits operation down to 45 deg F.

2.4 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Controls for HVAC".
- B. Thermostat: To control compressor and evaporator fan, with the following features:
 - 1. Compressor time delay.
 - 2. 7-day/24-hour time control of system stop and start.
 - 3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
 - 4. Fan-speed selection including auto setting.
- C. Automatic-reset timer to prevent rapid cycling of compressor.
- D. Condensate Overflow Switch
- E. Refrigerant Line Kits: Annealed-copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen, sealed, and with suction line insulated. Provide in standard lengths for installation without joints, except at equipment connections.
 - 1. This piping shall be capped throughout the construction to prevent any foreign materials from entering the piping. Fittings shall be wrought copper solder joint type. Dry nitrogen shall be bled through piping while joints are being brazed. Joints shall be as follows:
 - a. Copper to Brass - Silver Solder.
 - b. Copper to Copper – Silfos.
 - 2. Joints: Copper tubing connections shall be made up with 95/5 tin antimony solder or silfos, in accordance with the recommendations of the manufacturer or as specified hereinafter.
 - 3. Refrigerant Piping Insulation: Armstrong Armaflex insulation 1/2" thick with fittings covered with mitered sections of insulation and sealed with Armaflex 520 adhesive. All insulation on outdoor installation shall be additionally protected with two (2) coats of Armaflex WB pigmented acrylic latex finish.
 - a. Comply with ASTM C 534/C 534M, Type I.
- F. Condensate Drain Piping
 - 1. Copper Tubing: ASTM B88, Type L, M or DWV hard drawn.
 - a. Fittings: ANSI/ASME B16.18 bronze sand castings, ANSI B16.22 wrought copper, ANSI/ASME B16.23 cast brass, or ANSI/ASME B16.29 solder wrought copper.
 - b. Joints: ASTM B32, solder, Grade 95TA or grooved joints with EPDM gaskets.
 - 2. PVC Pipe: ASTM D1785, Schedule 40 and Schedule 80.
 - a. Fittings: ASTM D2466 for Schedule 40 pipe, or ASTM D2467 for Schedule 80 pipe.
 - b. Joints: ASTM D2564 and ASTM D2855, solvent weld.
 - 3. Condensate Drain Piping Insulation: Flexible Elastomeric Insulation: 1/2" closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units' level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install roof-mounted, compressor-condenser components on equipment supports as specified. Anchor units to supports with removable, cadmium-plated fasteners.
- D. Equipment Mounting:
 - 1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s).
- E. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified in Section 233113 "Ductwork and Ductwork Insulation." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Ductwork Accessories."

3.3 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 motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.4 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.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26

SECTION 23 81 27 – MINI-SPLIT SYSTEM AIR CONDITIONER

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Fan coil unit
- B. Outdoor unit
- C. Refrigerant piping
- D. Controls

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 230100 - GENERAL PROVISION FOR MECHANICAL WORK
- C. See drawings for further conditions, requirements, and schedules.

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product indicated.
 - a. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
 - b. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - c. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Approved Shop Drawings: For all split system air-conditioning units and related components. Provide in operation and maintenance manual.
- B. Operation and Maintenance Data: For split system air-conditioning units to include in operation and maintenance manuals.

1.5 WARRANTY

- A. Provide five-year warranty on compressors.

PART 2 - PRODUCTS

2.1 DUCTLESS SPLIT SYSTEMS

- A. Provide self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, controls, air filter, refrigerant cooling coil and outdoor package containing compressor, condenser coil and condenser fan.

2.2 ACCEPTABLE MANUFACTURERS

- A. Daikin, Trane, Carrier, Sanyo, Mitsubishi, Friedrich.

2.3 INDOOR UNIT

- A. The indoor unit shall be completely factory assembled and tested. Units shall have factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto restart function, 3-minute fused time delay and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The front grille shall be easily removed for cleaning.
- B. Indoor unit and refrigerant pipes will be charged with dehydrated air prior to shipment from the factory.
- C. Both refrigerant lines shall be insulated from the outdoor unit.
- D. The indoor units shall be equipped with a return air thermistor.
- E. Unit Cabinet
 - 1. The indoor unit shall have a white, "flat screen" finish.
 - 2. The drain and refrigerant piping shall be accessible from six(6) positions for flexible installation (right side, right back, right bottom, left side, left back and left bottom).
 - 3. The cabinet shall be supplied with a mounting plate to be installed onto a wall for securely mounting the cabinet.
- F. Fan
 - 1. The evaporator fan shall be an assembly consisting of a direct-driven fan by a single motor.
 - 2. The fan shall be statically and dynamically balanced and operate on a motor with permanent lubricated bearings.
 - 3. An auto-swing louver for adjustable air flow (vertically) shall be standard.
- G. Coil
 - 1. The evaporator coil shall be a nonferrous, aluminum fin on copper tube heat exchanger.
 - 2. All tube joints shall be brazed with silver alloy or phoscopper.
 - 3. All coils will be factory pressure tested.
 - 4. Condensate pad shall be located in unit.
 - 5. Provide with a remote condensate pump for condensate removal. Power from unit.
- H. Filter
 - 1. The return air filter provided will be a mildew proof, removable and washable filter.
- I. Refrigerant Piping
 - 1. All refrigeration piping shall be Type ACR hard drawn copper tubing and shall be precapped, precleaned and dry nitrogen charged at the factory. This piping shall be capped throughout the construction to prevent any foreign materials from entering the piping. Fittings shall be wrought copper solder joint type. Dry nitrogen shall be bled through piping while joints are being brazed. Joints shall be as follows:
 - a. Copper to Brass - Silver Solder

- b. Copper to Copper - Silfos.
 - 2. Joints: Copper tubing connections shall be made up with 95/5 tin antimony solder or silfos, in accordance with the recommendations of the manufacturer or as specified hereinafter.
 - 3. Refrigerant Piping Insulation: Armstrong Armaflex insulation 1/2" thick with fittings covered with mitered sections of insulation and sealed with Armaflex 520 adhesive. All insulation on outdoor installation shall be additionally protected with two (2) coats of Armaflex WB pigmented acrylic latex finish.
- J. Condensate Drain Piping
 - 1. Copper Tubing: ASTM B88, Type L, M or DWV hard drawn.
 - a. Fittings: ANSI/ASME B16.18 bronze sand castings, ANSI B16.22 wrought copper, ANSI/ASME B16.23 cast brass, or ANSI/ASME B16.29 solder wrought copper.
 - b. Joints: ASTM B32, solder, Grade 95TA or grooved joints with EPDM gaskets.
 - 2. PVC Pipe: ASTM D1785, Schedule 40 and Schedule 80.
 - a. Fittings: ASTM D2466 for Schedule 40 pipe, or ASTM D2467 for Schedule 80 pipe.
 - b. Joints: ASTM D2564 and ASTM D2855, solvent weld.
 - 3. Condensate Drain Piping Insulation: Flexible Elastomeric Insulation: 1/2" closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials.
- K. Controls
 - 1. The unit shall have a wall mounted remote infra-red controller capable to operate the system.
 - 2. The infrared remote controller shall consist of an On/Off Power switch, Mode Selector, Fan Setting, On/Off Timer Setting, Temperature Adjustment.
 - a. On/Off switch power the system on or off mode.
 - b. Mode selector shall operate the system in auto, cool, heat, fan, or dry operation.
 - c. Fan setting shall provide high, medium, or low fan speed.
 - d. On/Off timer is used for automatically switching the unit on or off.
 - e. Temperature adjustment allows for the increase or decrease of the desired temperature.

2.4 OUTDOOR UNIT

- A. Unit Cabinet
 - 1. The outdoor unit shall be completely weatherproof and corrosive resistant.
 - 2. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
- B. Fan
 - 1. The fan shall be a direct drive, propeller type fan.
 - 2. The motor shall be inverter drive, permanently lubricated type bearings, inherent.

- 3. A fan guard is provided on the outdoor unit to prevent contact with fan operation.
- C. Coil
 - 1. The outdoor coil shall be nonferrous construction with corrugated fin tube.
 - 2. Refrigerant flow from the condenser will be controlled via a metering device.
- D. Compressor
 - 1. The compressor shall be a rotary swing inverter-driven compressor.
 - 2. The compressor shall have an internal thermal overload.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all components in accordance with manufacturer's recommendation.
- B. Install all components in a manner to provide clearances required for proper operation and maintenance.
- C. Furnish equipment with charge of refrigerant and oil.
- D. Coordinate electrical connections required.

3.2 DEMONSTRATION

- A. Provide owner's maintenance personnel training as required to adjust, operate, and maintain equipment.

END OF SECTION 23 81 27

SECTION 23 82 39 – ELECTRIC UNIT HEATERS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Electric Cabinet Heaters
- B. Electric Unit Heaters
- C. Electric Ceiling Mounted Heaters
- D. Electric Wall Mounted Heaters
- E. Electric Washdown Fan-forced Unit Heaters

1.2 RELATED DOCUMENTS

- A. The General and Special Conditions, Division 01 Specification Sections, and all other Contract Documents (ESPECIALLY DIVISIONS 21, 22, 23 AND 26) are applicable to work under this section of the specifications. All the work under this section of the specifications shall be governed by any alternates and unit prices called for in the FORM OF PROPOSAL insofar as they affect this portion of the work.
- B. Section 230100 - GENERAL PROVISIONS FOR MECHANICAL WORK
- C. See drawings for further conditions, requirements, and schedules.

1.3 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Product Data: For each type of product
 - a. Include rated capacities, operating characteristics, furnished specialties, and accessories.
 - b. Wiring Diagrams: Power, signal, and control wiring.
 - c. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.4 CLOSEOUT SUBMITTALS

- A. Approved Shop Drawings: For all electric unit heaters and related components. Provide in operation and maintenance manual.
- B. Operation and Maintenance Data: For electric unit heaters to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. All electrical components and accessories shall be listed and labeled per requirements of NFPA 70, Article 100.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Berko, Chromalox, Markel, Trane, TPI/Reddi and Qmark.

2.2 ELECTRICAL CABINET HEATERS

- A. Basic Unit: Shall include chassis, coil, shall be fan wheel(s), housing(s), motor and insulation. Chassis shall be galvanized steel wrap-around structural frame with all edges flanged. Insulation is faced, heavy density glass fiber.

- B. Cabinet Finish: All cabinet parts shall be cleaned, bonderized, phosphatized, and flow-coated with baked-on primer. Provide final finish of spray applied baked-on enamel.
- C. Electric Heating Coils: Hydronic type finned-tube construction with resistance elements inserted in tubes. Units' factory wired with unit mounted heat switch, magnetic contactors, high temperature cutout safety control and fan override thermostat.
- D. Fans: Fan wheels shall be centrifugal, forward-curved, double width of aluminum.
- E. Motors: All motors shall have integral thermal overload protection and start at 78% of rated voltage. Motors shall operate satisfactorily at 90% of rated voltage on all speed settings and at 10% over voltage without undue magnetic noise. Temperature rise by winding resistance method shall not exceed 50 C (PSC motors) on high speed. All motors shall be factory run tested assembled in unit prior to shipping. Motor cords shall be quickly detachable at junction box by locking prong connector on vertical cabinet and wall hung units.
- F. Disconnect Switch: Factory wired, non-fusible in-housing.
- G. Electrical Performance: All cataloged models shall be wired in accordance with National Electric Code and be Underwriters' Laboratories, Inc., listed. Junction box for motor cord shall be provided unless otherwise specified.
- H. Provide factory standard discharge grilles.
- I. Filters: Provide 1" thick throwaway filter on all cabinet models.

2.3 ELECTRIC UNIT HEATERS

- A. Provide vertical unit heaters with heating and air delivery capacities as shown in schedule on drawings. The cabinet shall be made of 18-gauge die formed, furniture grade steel. Individual adjustable louvers with 30-degree downward stops shall be furnished to provide desired control of discharge air. All metal surfaces of the casing shall be phosphate coated to resist corrosion and finished in baked enamel. Heat to be of the draw-through air flow design.
- B. The electric heating bank shall consist of metal sheath heating elements. The elements shall have a copper clad steel sheath and corrosion resistance, and aluminum fins. Automatic reset thermal over-heat protection shall be of the linear capillary type wired for instantaneous de-energizing in case of thermal overload. Heating bank to have protective air inlet louvers.
- C. Motors shall be of the totally enclosed, continuous heavy-duty all-angle operation equipped with built-in thermal overload protection.
- D. Fans shall be aluminum directly connected to fan motor, designed specifically for unit heat application.
- E. Controls: Provide unit mounted thermostat to maintain space temperature unless otherwise noted.
- F. All heaters shall be U.L. listed and meet the requirements of the National Electrical Code.

2.4 ELECTRIC CEILING MOUNTED HEATERS

- A. Heater Section: The heater section shall consist of a 20-gauge steel chassis on which are mounted the heating elements, fan motor and blade, fan control, thermal cutout, and 3-pole contactor. Heater section shall be completely prewired.
- B. Heater Elements: The heating elements shall be guaranteed for five years and shall be of non-glowing design consisting of 80/20 NiCh resistance wire, enclosed in a steel sheath, to which steel plate fins are brazed. The elements shall cover the entire air intake area to ensure uniform heating of all discharged air.

- C. Motor and Controls: The fan motor shall be impedance-protected, permanently lubricated and with totally enclosed rotor. Fan control shall be bi-metallic, snap-action type and shall activate fan and heating element when the thermostat calls for heat and continue to operate the fan after the thermostat is satisfied and until all heated air has been discharged. Thermal cutout shall be bi-metallic snap-action type designed to automatically shut off heater in the event of overheating and reactivate the heater when temperature returns to normal.
- D. Operational Controls: Disconnect switch, and all interlock relays shall be installed within the heater enclosure.
- E. Recess Enclosure
 - 1. The box shall be designed for duty as a recessed rough-in box in masonry, T-Bar, or frame ceiling construction. The back box shall be 20-gauge galvanized steel and shall contain knockouts through which field wiring leads are brought. Enclosure to recess into a maximum 7 inches of ceiling space. An independent support system shall be used for T-Bar installation.
 - 2. The louvered recess faceplate shall be of 20 gauge cold rolled steel, phosphatized then electrostatically painted Antique White by a baked enamel process.
- F. Surface Enclosure
 - 1. The surface mounting plate shall be designed for duty as a rough-in box or masonry, T-Bar, or frame ceiling construction. The surface mounting plate shall be 20-gauge galvanized steel and shall contain knockouts through which field wiring leads are brought. Enclosure to extend a maximum of 16 inches into the heated space. An independent support system shall be used for T-Bar installation.
 - 2. The louvered surface wrapper shall be a contoured aluminum extrusion and 20-gauge sheet metal combination with rounded corners. The surface wrapper shall be electrostatically painted Antique White by a baked enamel process.

2.5 ELECTRIC WALL MOUNTED HEATERS

- A. Description
 - 1. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.
 - 2. 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. Cabinet
 - 1. Front Panel: Stamped-steel louver or extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.
 - 2. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
 - 3. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.
- C. Coil
 - 1. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection. Provide integral circuit breaker for overcurrent protection.

- D. Fan and Motor
 - 1. Fan: Aluminum propeller directly connected to motor.
 - 2. Motor: Permanently lubricated.
- E. Controls
 - 1. Controls: Unit-mounted thermostat.
 - 2. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

2.6 ELECTRIC WASHDOWN FAN-FORCED UNIT HEATERS (UH-XX)

- A. Enclosure and Motor
 - 1. Element housing shall be 16 gauge 304 or 316 stainless steel shroud. The outlet grille and louver assembly shall be 304/316 stainless steel and rotate for direction of discharge air. The heater shall have a 304/316 stainless steel inlet grille and fan guard. The motor shall be totally enclosed, permanently lubricated, and designed to resist moisture and corrosion. The fan blade shall be aluminum with a powder coated epoxy finish.
- B. Element
 - 1. The heating element shall be 304 or 316 stainless steel tube with 304/316 stainless steel fin material helically attached to the tube for even heat transfer. The element designed with the highest quality nickel-chromium resistance wire embedded in compacted efficient dielectric to ensure proper heat transfer.
- C. Control Panel
 - 1. The control enclosure shall be non-metallic NEMA 4X control panel water-tight and dust-tight. The enclosure and elements are attached to the control panel with stainless steel fasteners. Standard control components are factory-mounted and wired with access through control panel door on bottom of heater assembly. A standard door interlock disconnect switch shall be factory-mounted and wired for safety.
- D. Controls
 - 1. All controls shall be factory-mounted and wired in NEMA 4X panel. Terminal block, 24V transformer, high temperature limits, contactor and fusing if required by NEC are mounted and wired in control panel. A three-position switch (Off-Heat-Fan) shall be mounted on side of control panel for access from outside the panel. A pilot light to indicate power is on for safety shall be located on side of control panel. A wall mounted NEMA 4X thermostat is an optional accessory.
- E. Mounting Bracket
 - 1. A formed 304/316 stainless steel bracket shall be used on 3.3 thru 15 kW units. A cast iron epoxy painted bracket shall be used on 20 thru 48 kW units. Above brackets shall be combination wall/ceiling type. Optional mounting brackets are available.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all units and accessories in accordance with manufacturer's recommendations.
- B. Install all units in a manner to provide clearances for proper operation accessibility and maintenance.
- C. Coordinate electrical connections required.

3.2 DEMONSTRATION

- A. Provide Owner's maintenance personal training as required to adjust, operate, and maintain heaters.

END OF SECTION 23 82 39

SECTION 26 05 00 – GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. All drawings and general provisions of the contract, including the General and Supplementary Conditions and Division 01 Specifications apply to all specifications in Divisions 26, 27 and 28. In addition, the general requirements described within this specification section, 260500 General Requirements, apply to all specifications in Division 26, 27, 28 and the Contract Drawings.
- B. The contractor is responsible for obtaining and paying for all building permits, fees, licenses and inspections required by the governing agencies.
- C. The drawings and specifications constitute the Contract Documents. They complement each other. All items shown on the drawings and/or listed in the specifications shall be provided and installed by the Contractor unless specifically noted that it will be provided and/or installed by others. In the event there is a conflict within the Contract Documents, the Contractor shall notify the Engineer immediately. If a clarification is not given, the Contractor shall bid the more stringent of the two requirements.
- D. The Engineer does not define the scope of work for individual trades, subcontractors, material suppliers or vendors. Any sheet numbering system or reference to a specific trade in the contract documents is used solely for the Engineer's convenience and it is not intended to define a subcontractor's scope of work. It is the responsibility of any contractor, subcontractor, manufacturer or supplier preparing bids for this project to obtain and review the complete set of drawings and specifications.
- E. Any materials, labor, equipment or services not specifically mentioned herein which may be necessary to complete any part of the electrical systems described in the drawings and/or specifications shall be included as part of the Contract.
- F. References in the Contract Documents to any specific manufacturer and/or catalog numbers are intended to establish a standard of quality and not to limit competition. Proposed equivalent manufacturers shall be provided to the Engineer a minimum of 14 days prior to bid.
 - 1. These references to a specific manufacturer and/or catalog number represent a 'basis-of-design.' The Engineer has used the specific characteristics of the basis-of-design product(s) in coordination with other trades. These characteristics include, but not limited to, the following: dimensions, weight, working clearances, and interconnections with other trades. If the contractor elects to provide alternative products to the basis-of-design with deviating characteristics affecting other trades, it is the contractor's responsibility to coordinate all modifications required by the alternative product(s) with all other trades involved and to provide complete and operational systems. Work required for the alternative product(s) that is above and beyond work required to install the basis of design shall be borne by the Contractor at no additional cost to the Owner.
- G. All work performed in the Contract shall comply with all relevant codes adopted by the state and locality in which the project is located.
- H. All electrical components, devices and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.2 DIGITAL DATA AND FILE TRANSMISSION

- A. Sub-Contractors (SC) requiring digital files to prepare shop drawings and governmental agency submittals shall make their request through the Construction Manager (CM) or General Contractor (GC).

1. The CM/GC shall compile a list of requested drawings from the respective SC's and submit one comprehensive list to STW.
 2. STW will provide the CM/GC with a digital file transmission release form. The CM/GC may sign and return or have the requesting SC's sign and return to STW through the CM/GC.
 3. After receiving the signed release form, STW will provide one set of all requested digital files to the CM/GC to then distribute to the appropriate SC's.
 4. STW will provide AutoCAD/dwg files.
 - a. Revit/BIM models will not be provided to contractors. Projects completed using REVIT will be exported to AutoCAD prior to releasing.
- B. The project architect is the owner/author of the floor plans and reflected ceiling plans.
1. The architect must approve the release of these plans before STW can release our respective drawings.
 2. Requests for floor plans and/or reflected ceiling plans only shall be made directly to the architect.

1.3 WARRANTY

- A. At a minimum the Contractor shall warranty all defects in material and labor for one year starting from the date of substantial completion. In the event of a multi-phased renovation, all warranty periods shall start on the date of substantial completion of the final phase. Additional warranties may be required and will be described within the associated specification section.

1.4 SHOP DRAWINGS

- A. The Engineer's review is for general conformance with the design concept as it relates to the Engineer's scope of services. The contractor shall remain responsible for compliance with the project's contract drawings and specifications. Any markings, comments or lack of any notation on the returned submittals shall not be construed as relieving the contractor from this responsibility. Under no circumstances shall submittal and review of the shop drawings be interpreted as acceptance of a modification or change to the contract documents. The contractor remains responsible for details and accuracy, for confirming and correlating all quantities and dimensions, and for performing its work in a safe manner.
- B. The Contractor shall provide the Engineer with any and all product cutsheets, dimensioned drawings, wiring diagrams or any other documentation which may be required to describe the material to be provided as part of this Contract. Refer to the respective specification sections for additional requirements.
- C. The Engineer requires a minimum of two (2) weeks to review shop drawings. The contractor shall account for this review time in the project schedule.
1. The contractor can notify the Engineer if there are specific shop drawings that require a quicker review time. The Engineer will make efforts to accommodate this request.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Protect materials during delivery and storage and maintain within manufacturer's written storage requirements.
- B. At a minimum, store indoors in a clean, dry space with uniform temperature to prevent condensation.
- C. Protect electronics from potential damage from electrical and magnetic energy

1.6 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals are NOT a copy of the shop drawings or equipment cutsheets. They are intended to be reference materials on how to operate and maintain equipment.
- B. All information shall be type written and machine generated.
- C. All information required to be included in the operation and maintenance manuals shall be provided in digital PDF format and with hard copies.
 - 1. Hard copies shall be bound a hard cover three ring binder.
 - 2. The binder shall be labeled on the cover of the spine with the following information:
 - a. Project Name
 - b. Date of Construction
 - c. Installing contractor's name
 - d. Consultant's name
- D. Each manual shall contain the following:
 - 1. A title page with the same information included on the binder cover.
 - 2. A table of contents.
 - 3. Dividers separating each section and labeled to correspond with the table of contents.

1.7 RECORD DRAWINGS

- A. The contractor shall maintain one set of marked-up paper copies of the contract drawings and specifications for record documents.
 - 1. Make marks using colored instruments. Do not use the color black or a lead pencil.
- B. The set of drawings and specifications used for the record documents shall not be used in the field for construction purposes. The record documents shall be clean, dry, legible, and undamaged.
- C. Mark the record drawings as necessary to incorporate the following:
 - 1. Addendums which changed the original drawings.
 - 2. Change orders, supplemental instructions or similar change directives that modify the contract drawings.
 - 3. Any deviations from the contract drawings including locations of equipment and devices, and panel circuits.
 - 4. Locations and depths of underground electrical installations located outside the building footprint.
 - a. The contractor shall reference the dimensions of the installations from permanent structures and note on the record drawings.
- D. Mark the record specifications as necessary to incorporate the following:
 - 1. Addendums which changed the original specifications.
 - 2. Change orders, supplemental instructions or similar change directives that modify the contract specifications.
- E. Refer to the Division 1 specifications for additional record drawing requirements.

1.8 PUNCH LISTS

- A. It is the responsibility of the contractor to notify the engineer when the contractor is ready for punch lists to be performed. The contractor shall notify the engineer a minimum of one week prior.
 - 1. Above ceiling punch lists shall not be scheduled until the following have been completed, at a minimum. The following is not intended to be a comprehensive checklist:
 - a. Ceiling grid installed.
 - b. Light fixtures installed, wired and independently supported.
 - c. Ceiling mounted devices installed and wired. Ceiling tiles may be installed where necessary for the installation of the devices.
 - d. Low-voltage cabling installed and supported.
 - 2. Above ceiling punches and back-checks shall occur prior to the installation of ceiling tiles. If ceiling tiles have been installed, it will be contractor's responsibility to assist the engineer during the punch or back-check. The contractor shall provide a ladder, raise ceiling tiles and replace, in areas deemed necessary by the engineer.
- B. The engineer will prepare a written list of deficiencies and distribute to the contractor. The contractor shall make all corrections. The contractor shall initial and date each punch list item indicating the item has been corrected. After all items have been corrected the contractor shall return the initialed punch list to the engineer and then request a back check of the punch.
 - 1. The engineer will not back-check until the punch list has been completed and returned.
- C. The engineer will perform one above ceiling punch list, one back-check, one final punch list and one back-check.
 - 1. If additional punch lists are required due to incomplete work, the engineer shall be financially compensated for their additional time and effort. The contractor will be financially responsible for this additional time and it will be billed at our standard hourly rates.
 - 2. If additional back-checks are required due to the contractor's failure to complete identified items, the engineer shall be financially compensated for their additional time and effort. The contractor will be financially responsible for this additional time and it will be billed at our standard hourly rates.

1.9 OWNER TRAINING

- A. Where owner training for specific systems is specified, the contractor shall provide at a minimum the following:
 - 1. The following shall occur prior to scheduling owner training:
 - a. The respective system MUST be fully operational, software programmed, all punch list items completed, and the resolution tracking form completed (if third party commissioning is provided for the project).
 - b. Manufacturer's startup and testing has been completed. The owner training shall not be scheduled for the same day as startup and testing.
 - c. The operation manuals shall be submitted to the engineer for review.
 - i) Include owner training agenda.
 - 2. Sign-in sheet documenting the attendees.

3. The operation manual for the respective system. A copy shall be provided to each attendee.
 - a. The operation manual shall be reviewed with the attendees in conjunction with the physical demonstration of the system.
4. Physical demonstration of how to operate, program, adjust and maintain the respective system.
5. The contractor shall digitally record training sessions (video and audio). A copy of the recording shall be provided with the O&M manual.

1.10 EXISTING SYSTEMS

- A. All existing equipment and systems are assumed to be fully functioning and operating properly in all their capacity unless otherwise noted.
- B. Pre-Test: It is the responsibility of the contractor to provide functional testing and document in writing the condition, functionality and deficiencies of any existing equipment or systems prior to any renovations.
 1. The contractor shall provide a copy of this report to the design team and owner for review and comment.
 2. The owner will determine the procedures and/or methods for addressing deficiencies should any be discovered.
- C. Post-Test: It is the responsibility of the contractor to provide functional testing and document in writing the condition, functionality and deficiencies of any existing equipment. This test shall occur prior to the owner occupying the facility or substantial completion, whichever occurs first.
 1. The post-test is to confirm the existing systems operate at the same capacity as they did prior to construction beginning.
 2. The contractor shall provide a copy of this report to the design team and owner for review and comment.
- D. If the contractor fails to document the condition of any existing equipment or systems and provide a written report prior to any work commencing, and subsequently the existing system is found to have deficiencies, it will be the contractor's financial responsibility to make any and all corrections.
 1. It will be at the Owner's and Engineer's sole discretion as to the extent corrections will be required, including but not limited to the full replacement of the respective equipment or system.

1.11 DEMOLITION

- A. The owner reserves the right to keep any removed items. The contractor is responsible for removing any unwanted items from the site.
- B. The contractor shall dispose of any demolished items in accordance with all applicable local, state and federal regulations.
- C. Hazardous Material
 1. Shrout Tate Wilson Consulting Engineers, PLLC is not a design professional in the determination of the presence of hazardous material or involved in making recommendations regarding hazardous material.
 2. If the contractor encounters any suspected hazardous material, they shall immediately notify the owner.

1.12 INSTALLATION

- A. All work shall be installed in a neat and workman like manner complying with standards in NECA1, Standard for Good Workmanship in Electrical Construction.
- B. The drawings are diagrammatic only. It is the responsibility of this Contractor to coordinate the installation of the specified components with all other trades to accomplish the following:
 - 1. Allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. Provide for ease of disconnecting equipment with minimum interference with other installations.
 - 3. Mount control panels, relay panels, VFD's, or similar, at locations where they are accessible without the use of a lift or ladder taller than 8 feet unless otherwise noted. Mount in mechanical rooms, or similar where possible. Provide additional local disconnect switch(es) as required where control panels, relay panels, VFD's, or similar are located remoted from the equipment served. Coordinate final locations with Architect/Engineer.
 - 4. Allow right of way for piping and conduit installed at required slope, so connecting raceways, cables, wireways, cable trays and busways will be clear of obstructions and of the working and access space of other equipment.
 - 5. Maintain all working clearances required by the building codes and equipment manufacturer.
- C. All penetrations through walls, ceilings, and floors shall be sealed.
 - 1. Seal space around penetrations so no voids remain. Finish to match surrounding surfaces.

END OF SECTION 26 05 00

SECTION 26 05 01 - GENERAL COMMISSIONING REQUIREMENTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to the General Requirements Specifications, Section 260500.
- B. This specification is to inform the contractor of the commissioning requirements for this project and their roles and responsibilities to support this effort.
 - 1. Section Includes:
 - a. General requirements for coordinating and scheduling commissioning.
 - b. Commissioning meetings.
 - c. Commissioning reports.
 - d. Use of test equipment, instrumentation, and tools for commissioning.
 - e. Construction checklists, including, but not limited to, installation checks, startup, performance tests, and performance test demonstration.
 - f. Commissioning tests and Commissioning test demonstration.
 - g. Adjusting, verifying, and documenting identified systems and assemblies.
- C. The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that the commissioned systems have been installed in the prescribed manner and operate within the performance guidelines set in Owner's Project Requirements (OPR). The Commissioning Authority (CxA) shall provide the owner with an unbiased, objective view of the system's installation, operation, and performance. This process is not intended to eliminate or reduce the responsibility of the design team or installing contractors. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The CxA will be a member of the construction team, administering and coordinating commissioning activities with the design team, general contractor, subcontractors, manufacturers and equipment suppliers.
- D. The commissioning of the building systems will be performed by a certified Commissioning Agent under a separate contract. The Electrical Contractor, and any of their sub-contractor(s) that the Commissioning Agent deems necessary, shall assist the commissioning agent in performing the commissioning services.

1.2 ELECTRICAL SYSTEMS

- A. The following electrical systems will be commissioned:
 - 1. Lighting and Lighting Controls

1.3 DEFINITIONS

- A. Checklists – Verification checklists that are developed and used during all phases of the commissioning process to verify that the Owner's Project Requirements are being achieved. This includes checklists for general verification, plus testing, training, and other specific requirements.
- B. Commissioning – Commissioning is a process that enhances the delivery of a project by verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the owner's project requirements (design intent). In addition to uncovering deficiencies in design or installation using peer review and field verification.

- C. Commissioning Authority (CxA) – The entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process.
- D. Commissioning Plan - An overall plan developed by the commissioning agent that provides the structure, schedule and coordination planning for the commissioning process.
- E. Commissioning Report - The document prepared during the acceptance phase of the commissioning process after all functional performance tests are completed. It includes an executive summary, building description, the completed commissioning plan, and all documentation generated during the commissioning process along with completed commissioning test plans.
- F. Commissioning Team - The individuals who through coordinated actions are responsible for implementing the commissioning process.
- G. Commissioning Technician (CxT) – Commissioning personnel who work under the direction and supervision of the Commissioning Authority. The CxT implements tasks delineated by the Commissioning Plan and assigned by the CxA.
- H. Functional Test – Functional tests are performed on an individual component of a system to determine if that component independently performs the functions intended and produces the capacity specified.
- I. Systems Manual – A system focused composite document that should provide the information needed to understand, operate, and maintain the systems and assemblies and to inform those not involved in the design and construction process about the systems and assemblies.
- J. Test Procedure – A written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.
- K. Verification – range of checks and tests carried out to determine whether components, subsystems, systems, and interfaces between systems operate in accordance with the contract documents.

1.4 ROLES OF THE COMMISSIONING AUTHORITY

- A. The primary responsibility is to inform the owner, the design team, and the construction team of the status, integration, and performance of commissioned systems within the facility.
- B. The CxA shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction process. This shall include system verification, functional performance testing, and conformance with the intended design of each system. Services include documenting construction observations, verification and functional performance testing, and documenting proper distribution of performance and operating information to the owner's O&M staff.
- C. The CxA shall assist the responsible parties in maintaining a high-quality installation by meeting or exceeding prevailing standards and specifications.
- D. The CxA shall observe and coordinate testing as required to assure system performance meets the design intent.
- E. The CxA shall document the results of the performance testing directly and/or assure that the appropriate technicians document testing. The CxA shall approve standard forms to be used by all parties for consistency of approach and type of information to be recorded.

- F. The CxA shall provide technical expertise to oversee and verify the correction of deficiencies found during the commissioning process.
- G. The CxA is an individual separate from the design team with specific knowledge of commissioned systems on the project. The CxA shall investigate the scope and extent of the problem and facilitate communication to determine responsibilities by delineating specifications. The CxA shall monitor resolution for conformance with design intent and prevailing industry standards.
- H. The CxA shall document the date of acceptance as determined by the General Contractor, Owner and Design Team. System Verification Checklists and Functional Performance Test results may be used in determining the start of the warranty period for commissioned systems and subsystems.
- I. The CxA will review operating and maintenance materials for commissioned systems.

1.5 COMMISSIONING EXECUTION

A. Commissioning Team

- 1. The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. The electrical contractor shall appoint one representative to the commissioning team. It is necessary for this person to have a long-term commitment to this project. Switching representatives during the project will reduce the ability of the CT to provide continuity and acceptable results to the building owner. The representative must maintain an ongoing supervisory position on this project.

B. Commissioning Plan & Kick Off Meeting

- 1. The CxA will develop a Commissioning Plan to define members appointed to the CT, as well as set a schedule for commissioning activities throughout the project.
- 2. The CxA will coordinate and execute a commissioning kick off meeting at the beginning of the project with the CT to define commissioning responsibilities and expectations for the project.

C. Commissioning Meetings

- 1. Commissioning meetings will be held in conjunction with progress meetings and/or contractor coordination meetings to avoid extra mobilization costs. The CxA will be on site for the Cx meetings. Commissioning meetings will be used to address any problems that alter the design intent or affect the commissioning process. These meetings provide an open forum for exchange of ideas between contractors, vendors, designers, users and owners. Site observation walkthroughs by the CxA will be coordinated in conjunction with the commissioning meetings or separately as required to implement the commissioning process.

D. Resolution Tracking Forms (RTF)

- 1. The use of Resolution Tracking Forms is a method employed by the CxA to monitor and record problems, their causes, and solutions. The use of these lists promotes communication between the installing contractors, design team, commissioning agent, and owner, in order to expedite their resolution in a timely manner.
- 2. The CxA will regularly submit RTF's to the CT in order to document and resolve deficiencies as quickly as possible. The frequency of RTF submission will be adjusted as project conditions dictate.

E. Submittal Reviews

1. The CxA will review shop drawings and equipment submittals for information affecting the commissioning process. Comments will be delivered to the Engineer for review within 8 business days of receiving the shop drawings.
- F. Systems Manual
1. The CxA will assist contractors by reviewing the systems manual for completeness and to ensure that it provides future operating staff the information needed to understand and optimally operate the commissioned systems of the project.
- G. System Verification Checklists (SVC's)
1. The CxA will write SVC's based on the contract documents. These checklists will be created for systems and subsystems to be commissioned. Draft copies will be submitted to the CT for review and comment prior to placement on the job site. A master copy of the SVC's will be bound in a three-ring binder and placed on the job site for use by the installing contractors. No system will be started until the appropriate SVC's have been completed.
 2. The CxA will review the SVC for each piece of equipment prior to start-up. Equipment will be released for start-up only after these checklists have been completed by the installing contractor and reviewed by the CxA.
- H. Start-Up
1. Start-up of commissioned systems will be witnessed the CxA as necessary. The appropriate contractors and/or manufacturer's representative will be required on site to perform start-up. No system will be started until the appropriate SVC's have been completed. No system will be started until the Manufacturer's checklists have been completed. Start-up will be performed according to the Manufacturer's recommended procedures. The CxA will visit the site to review completeness of installation in conjunction with progress meetings prior to starting commissioned equipment.
 2. CT members involved in installation, fabrication, manufacture, control, or design of equipment are required to be present at the time of start-up. A factory-authorized technician will be on site to start equipment when required by the specifications. This will minimize delays in bringing equipment on line and expedite acceptable functional performance testing.
- I. Functional Performance Tests (FPT's)
1. The CxA will write FPT's based on the design documents. These tests will be created for systems and subsystems to be commissioned.
 2. Each commissioned system(s) will be tested. The sampling rate for testing is 100%. This will be coordinated and witnessed by the CxA and, if they wish to be present, the owner's maintenance staff. Witnessing the FPT's will serve as a complement to the O&M Training. No FPT's will be performed until the systems have been started, the TAB report has been submitted and reviewed, and the completion of the control system has been documented through point-to-point checklists and other documentation.
 3. The Functional Performance Tests will test systems to assure conformance to the manufacturer's and contract document requirements.
 4. Off-season mode testing will be implemented as necessary to assure conformance with the construction documents. Installing contractors will be expected to participate as required by the project specifications.
- J. Building Turn-Over / Owner Orientation / User Training

1. The CxA will assist contractors in preparing, coordinating and reviewing O&M manuals, working closely with each contractor to achieve specificity and completeness.
2. The CxA will review as-built drawings, and work closely with each contractor to achieve specificity and completeness.
3. Owner training will be coordinated with the assistance of the CxA. The installing contractor or manufacturer's representative will provide the training. The CxA will witness this training. This training should include both classroom training and hands-on operational training. The CxA will visit the site during the Turnover and Training period to assure that any on-going problems related to commissioned systems are being addressed and corrected in a timely and efficient manner.
4. The CxA will assist the owner/user with warranty issues.
5. The CxA will assist in the coordination of off-season testing, calibrating, and servicing as specified in the contract documents.
6. The CxA will provide a Final Commissioning Report. The report shall include test procedures and results and shall be identified as a "Final Commissioning Report". This report shall be delivered to the Owner and shall include the following:
 - a. Results of functional performance tests (FPTs).
 - b. Disposition of deficiencies found during testing, including details of corrective measures used or proposed.
 - c. All Completed System Verification Checklists (SVCs).
 - d. Functional performance test procedures used during the commissioning process including measurable criteria for test acceptance, provided herein for repeatability.
7. Exception: Deferred tests which cannot be performed at the time of report preparation due to climatic conditions.

K. Warranty Period

1. The CxA will participate in a 10th month walk-through and review meeting to observe the operation of the commissioned systems. The following items will be reviewed and discussed: warranty issues, energy usage, maintenance practices, usage changes, and chronic problems, as well as other issues affecting the owner and the operation of the commissioned systems.

1.6 ROLES AND RESPONSIBILITIES OF INSTALLING CONTRACTORS

A. Electrical Contractor Responsibilities (EC)

1. Attend and participate in commissioning meetings scheduled by the CxA.
2. Verify proper installation and performance of all electrical systems to be commissioned.
3. Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling startup of commissioned equipment.
4. Monitor and respond to Resolution Tracking Forms distributed by the CxA in order to expedite corrective actions necessary to achieve design intent.
5. Provide an electrical system technician to assist during verification and performance testing.

6. Correct any issues or deficiencies that may be discovered during the course of construction.
7. Participate in the Functional Performance Tests as required to achieve design intent.
8. Participate in O&M Training as required by project specifications.
9. Provide a complete set of as-built drawings and O&M manuals for review.

END OF SECTION 26 05 01

SECTION 26 05 05 – PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to the General Requirements Specifications, Section 260500.
- B. Section Includes:
 - 1. Penetrations in fire-resistance-rated walls.
 - 2. Penetrations in horizontal assemblies.
 - 3. Penetrations in smoke barriers.

1.2 SCOPE

- A. Provide fire and/or smoke stopping around, or in, any components which penetrate rated assemblies as required to maintain the rating of that assembly.

1.3 SUBMITTALS

- A. Product Data
 - 1. Provide product data for each type of product to be utilized on this project.
- B. Shop Drawings
 - 1. Provide shop drawings detailing materials, installation methods, and relationships to adjoining construction for each through-penetration firestop system, and each kind of construction condition penetrated and kind of penetrating item.
- C. Qualifications Data
 - 1. Provide documentation from a qualified testing and inspecting agency indicating that each through-penetration firestop configuration submitted has been tested for the manner in which it is to be installed.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
- B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:
 - 1. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:
 - a. Classification markings on penetration firestopping correspond to designations listed by the following:
 - i) UL in its "Fire Resistance Directory."
 - ii) Intertek ETL SEMKO in its "Directory of Listed Building Products."
 - iii) FM Global in its "Building Materials Approval Guide."

- C. Single-source responsibility: Obtain through-penetration fire-stop systems for each kind of penetration and construction condition from a single-supplier.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. 3M
- B. Dow Corning Corporation
- C. Hilti Construction Chemicals

2.2 PENETRATION FIRESTOPPING

- A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - 1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - 1. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
 - 2. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
- D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.
 - 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30-inch wg at both ambient and elevated temperatures.
- E. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.
- F. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- G. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - 1. Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.
- H. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.
 - 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-wool-fiber or rock-wool-fiber insulation.

- b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
- 2. Temporary forming materials.
- 3. Substrate primers.
- 4. Collars.
- 5. Steel sleeves.

2.3 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. 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, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

- A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

3.2 INSTALLATION

- A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- C. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- D. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.
- E. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- F. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.
- G. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.
- H. Install fill materials for firestopping by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

- I. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.
- J. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration throughout the duration of this project.

END OF SECTION 26 05 05

SECTION 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to the general requirements specification, Section 26 05 00.
- B. Section includes grounding and bonding systems and equipment.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Provide product data for each product to be used on this project.

1.3 OPERATION AND MAINTENANCE MANUALS

- A. Provide dimensioned record drawing locating test wells, ground rods or other grounding electrodes installed outside the building footprint.
- B. Provide ground resistance measurements.

1.4 QUALITY ASSURANCE

- A. All components shall be manufactured, listed and installed in accordance with the applicable NEMA, UL and ASTM standards.
- B. Grounding and bonding materials and equipment shall comply with the UL 467 Standard.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. General Requirements
 - 1. Refer to the raceways, boxes, power conductors and cables specification, Section 26 03 33 for conductor requirements.
 - a. All grounding and bonding conductors shall be insulated.

2.2 GROUNDING BUS BARS

- A. Grounding bus bars shall be predrilled rectangular bars of annealed copper.
 - 1. Minimum of ¼" D x 4" H.
 - 2. Minimum of 20" L. Provide additional length as necessary to accommodate all conductor connections.
 - 3. Provide quantity and diameter of predrilled holes as required to accommodate connections.
- B. Provide stainless steel mounting brackets.
- C. Provide fiberglass-reinforced thermo-set polyester stand-off insulators.

2.3 CONNECTORS

- A. Connectors shall be factory-fabricated of the size, ampacity rating, material type and class for the application and service indicated.
- B. Welded connections shall be exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING RODS

- A. Ground rods shall be copper-clad steel 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to the electrical system grounding detail on the drawings for additional information.
- B. Install an equipment grounding conductor with all feeders and branch circuits.
- C. All grounding and bonding conductors shall be installed in raceways, boxes or enclosures. Refer to the Raceways, Boxes, Power Conductors and Cables specification, Section 260333 for requirements.
- D. The grounding conductors shall be furnished from the factory with the following insulation colors.
 - 1. Grounding conductors shall be green.
 - 2. Isolated grounding conductors shall be green with one or more continuous yellow stripes.
- E. Install grounding busbars per the following unless otherwise noted on the drawings.
 - 1. Locations
 - a. Install a busbar at each electrical service, outside of the service enclosure.
 - 1) If the facility has more than one electrical service, provide a bonding conductor between each service grounding busbar. Size conductor as a grounding electrode conductor.
 - b. In each communication closet, MDF, IDF, or similar space.
 - 1) Provide bonding conductor from the main service grounding busbar to each communication closet busbar.
 - 2. Mounting
 - a. Mount in an accessible location.
 - b. Install a minimum of 18" above finished floor.
 - c. Install horizontally on the wall, a minimum of 2" from the wall.
 - 3. Provide conductor connection to bus bars using compression-type, long-barrel, two-bolt lugs.
- F. Where isolated grounding is indicated on the drawings, comply with the following:
 - 1. Provide an additional equipment grounding conductor (isolated grounding conductor) to the equipment indicated on the drawings.
 - a. The isolated grounding conductor shall originate at the service grounding busbar, insulated/isolated grounding busbar in a sub-panel or at the grounding busbar of a separately derived system.
 - 2. The isolated grounding conductor shall remain separated/isolated from the equipment grounding conductor except where it is bonded at the service or at the separately derived system.
- G. Lightning Protection Systems (LPS) shall be bonded to the grounding electrode system. Bond the LPS to the grounding electrode system at the grounding busbar provided at the electrical service.
 - 1. The bonding conductor shall be the same size as the grounding electrode conductor.
- H. Provide the following to form the grounding electrode system:
 - 1. Ground Rods

- a. Provide a minimum of (3) ground rods, unless otherwise noted on the drawings.
 - b. Provide a test access well for a minimum of (1) of the ground rods, unless otherwise noted on the drawings. The test well shall be installed on the ground rod closest to the service entrance.
 - 1) Test access wells shall be handholes. Set top flush to finished grade or floor. Refer to Section 260633, Raceways, Boxes, Power Conductors and Cables for handhole requirements.
 - 2) The top of the ground rod installed in the test well shall be approximately 6 inches above grade. The other ground rods shall be installed a minimum of 18 inches below finished grade.
 - 3) Provide bolted connectors for conductor connections at the ground rod installed in the test well. Connections to the remaining grounds rods shall be by exothermic welding.
 - c. The ground rods shall be evenly spaced with 20 feet of separation. Arrange the ground rods in a triangular pattern.
 2. Provide connection to the main metal water service pipe(s). Use bolted clamp connectors. Provide connection at the point where the piping enters the structure on the street side of any fittings. Provide bonding jumper across any dielectric fittings between the street side and building side of pipes.
 - a. The fire suppression service entrance shall be bonded to the grounding electrode system. However, it shall not be used as a grounding electrode.
 3. Provide connection to the metal building structure. Use welded connections.
 4. Provide a concrete-encased electrode for new construction or bond to the concrete-encased electrode where accessible in existing structures.
 - a. Electrically conductive coated steel reinforcing bars or rods may be utilized.
 - b. If reinforcing bars or rods are not present, or do not meet the minimum requirements listed in the NEC, the contractor shall provide a bare copper conductor not smaller than 4 AWG.
 5. The contractor shall bond to other grounding electrodes if present.
- I. Separately Derived Systems
1. Connect the grounded conductor of the derived system(s) to the building grounding electrode system.
 2. Single separately derived system, where utilized as part of the power distribution network.
 - a. Provide a grounding electrode conductor from the main electrical service grounding busbar to the separately derived system.
 - b. Bond the separately derived system to the structural steel and metal water piping in the area.
 3. Multiple separately derived systems, where utilized as part of the power distribution network.
 - a. Provide a common grounding electrode conductor from the main electrical service grounding busbar to the separately derived systems.

- b. Provide a grounding electrode conductor tap from each separately derived system to the common grounding electrode conductor.
 - c. The common grounding electrode conductor shall be a minimum of 3/0 AWG (CU).
 - d. Bond the structural metal building frame and metal water piping to the common grounding electrode conductor in the area served by the separately derived system.
- J. Make all connections so the possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- K. For grounding conductor terminations and connections not specifically addressed or noted otherwise in this specification, provide the following:
 - 1. Utilize bolted connectors for pipe and equipment grounding conductor terminations.
 - 2. Utilize welded connectors for underground connections.
- L. Install bonding jumpers in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

3.2 FUNCTIONAL TESTING

- A. Tests and Inspections:
 - 1. After installing the grounding system but before permanent electrical circuits have been energized, provide the following:
 - a. Inspect the physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - b. Measure the entire grounding electrode system's loop resistance. Take measurements from the grounding electrode conductor installed between the electrical service ground-neutral bond and the main electrical service grounding busbar.
 - c. Measure each grounding electrode's resistance to earth before any conductors are connected.
 - d. Measure 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.
 - e. Measurements may be performed using the fall-of-potential method according to IEEE 81 or using a clamp-on earth resistance tester.

- f. Record measurements and include with the operation and maintenance manual.
 - 1) Document the type of instrument(s) used, the manufacturer and model number.
 - 2) Document the measurements for the entire loop resistance and each grounding electrode.

END OF SECTION 26 05 26

SECTION 26 05 29 – HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to the general requirements specification, Section 26 05 00.
- B. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.2 SCOPE

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. 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.
- D. Seismic:
 - 1. Refer to the structural drawings and specifications for seismic design requirements.
 - 2. Refer to the Vibration and Seismic Controls for Electrical Systems specification, section 26 05 48 for additional requirements.
 - 3. The specified work in this section must withstand the seismic hazard design loads for installed elevation above and below grade.
 - a. The term 'withstand' means 'unit must remain in place without separation of parts from unit when subjected to specified seismic design loads [and unit must be fully operational after seismic event].'

1.3 COORDINATION

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

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. Acceptable Manufacturers:
 - 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. 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. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Acceptable Manufacturers:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated 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. Acceptable Manufacturers:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. 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 Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted 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.
- D. Provide vibration and seismic controls with hangers and supports.

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.
- 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 Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

SECTION 26 05 33 – RACEWAYS, BOXES, POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to the General Requirements Specification, Section 260500.
- B. This Section includes:
 - 1. Raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
 - 2. Building wires and cables rated 1,000V and less.
 - 3. Connectors, splices, and terminations rated 1,000V or less.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. FMC: Flexible metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. LFNC: Liquidtight flexible nonmetallic conduit.
- F. RNC: Rigid nonmetallic conduit.
- G. RSC: Rigid galvanized steel conduit.

1.3 SUBMITTALS

- A. Product Data
 - 1. Provide product data for each product to be used on this project.
- B. Shop Drawings
 - 1. Provide shop drawings for the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
 - a. Custom enclosures and cabinets.
 - b. Surface raceway.
 - c. For handholes and boxes for underground wiring, including the following:
 - 1) Duct entry provisions, including locations and duct sizes.
 - 2) Frame and cover design.
 - 3) Grounding details.
 - 4) Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
 - 5) Joint details.

1.4 QUALITY ASSURANCE

- A. All components shall be manufactured, listed, and installed in accordance with the applicable NEMA, ASTM B3 and B8, UL, ANSI and SCTE standards.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Acceptable Manufacturers:

1. Alcan Products Corporation; Alcan Cable Division.
 2. American Insulated Wire Corp.; a Leviton Company.
 3. General Cable Corporation.
 4. Senator Wire & Cable Company.
 5. Southwire Company.
- B. General Requirements:
1. All conductors shall be copper and insulated unless otherwise noted on the drawings.
 2. Insulation be type THHN/THWN/THWN-2, 90°C, minimum 600-volt rating.
 3. Refer to the drawings for conductor sizes. The minimum conductor size permitted shall be No. 12 AWG. Conductors for branch circuits more than 75 feet (120V) and 150 feet (277V) from the panel to the first outlet shall not be smaller than No. 10 AWG.
 4. Solid conductor for No. 10 AWG and smaller; stranded conductor for No. 8 AWG and larger.
 5. Provide type SO, hard service cord for cord drops and connections to portable appliances.
- 2.2 METAL CLAD CABLE, TYPE MC
- A. Single circuits up to #10 AWG only.
 - B. Cable shall be listed for the environmental air-handling spaces.
 - C. Steel, interlocked armor. Aluminum is not permitted.
 - D. Mark cable according to UL's "Wire and Cable Marking and Application Guide."
- 2.3 CONNECTORS AND SPLICES
- A. Acceptable Manufacturers:
 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. Connectors and splices shall be factory-fabricated of the size, ampacity rating, material, type, and class for application and service indicated.
- 2.4 METAL CONDUIT AND TUBING
- A. Acceptable Manufacturers:
 1. AFC Cable Systems, Inc.
 2. Alflec Inc.
 3. Allied Tube & Conduit; a Tyco International Ltd. Co.
 4. Anamet Electrical, Inc.; Anaconda Metal Hose.
 5. Electri-Flex Co.
 6. Manhattan/CDT/Cole-Flex.

7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.
9. Wheatland Tube Company.
- B. Fittings for all types of conduit and tubing shall be listed for the type and size raceway with which used, and for application and environment in which installed.
- C. Provide steel, compression type fittings for EMT.
- D. Threaded fittings shall be used for RSC.
- E. Flexible Metal Conduit (FMC)
 1. Galvanized, corrosion resistant, high strength steel alloy.
 2. Helically formed metal strip, continuously interlocked.
- F. Provide joint compound for RSC. The compound shall be listed for use in cable connector assemblies and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.
- G. Refer to the drawings for colors/finish.
- H. Refer to drawings for sizes.
 1. Provide a minimum of 1-inch for conduit/tubing containing telecommunications cabling and audio/visual cabling.
 2. All other conduit/tubing shall be a minimum of 3/4 inch.

2.5 NONMETALLIC CONDUIT AND TUBING

- A. Acceptable Manufacturers:
 1. AFC Cable Systems, Inc.
 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 3. Arnco Corporation.
 4. CANTEX Inc.
 5. CertainTeed Corp.; Pipe & Plastics Group.
 6. Condux International, Inc.
 7. ElecSYS, Inc.
 8. Electri-Flex Co.
 9. Lamson & Sessions; Carlon Electrical Products.
 10. Manhattan/CDT/Cole-Flex.
 11. RACO; a Hubbell Company.
 12. Thomas & Betts Corporation.
- B. Fittings for all types of nonmetallic conduit and tubing shall be listed for the type and size of conduit or tubing type and material with which used, and for the application and environment in which installed.
- C. Refer to drawings for sizes.
 1. Provide a minimum of 1-inch for conduit/tubing containing telecommunications cabling and audio/visual cabling.
 2. All other conduit/tubing shall be a minimum of 3/4 inch.

- D. RNC shall be type Electrical Polyvinyl Chloride (EPC).

2.6 METAL WIREWAYS

- A. Acceptable Manufacturers:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
- B. Wireways shall be constructed of sheet metal unless otherwise noted on the drawings.
- C. Provide couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.
- D. Provide with hinged covers.
- E. Provide the manufacturer's standard enamel finish unless noted otherwise on the drawings.

2.7 SURFACE RACEWAY (WIREMOLD)

- A. Acceptable Manufacturers:
 - 1. Wiremold, Legrand LLC.
 - 2. Hubbell.
 - 3. Panduit
- B. Refer to the drawings for specific surface raceway requirements.

2.8 BOXES, ENCLOSURES, AND CABINETS

- A. Acceptable Manufacturers:
 - 1. Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.
 - 3. Hoffman.
 - 4. Hubbell Incorporated.
 - 5. Wiremold, Legrand LLC.
- B. Outlet and Device Boxes
 - 1. Dimensions:
 - a. Minimum 2 1/8 inches deep.
 - b. Minimum 2-gang (4-11/16-inch square) for all boxes.
 - 2. Provide plaster ring as required for device(s) and wall construction type.
- C. Sheet metal outlet device boxes and small pull and junction boxes shall be constructed of welded steel.
- D. Cast-Metal outlet device boxes and small pull and junction boxes shall be constructed of cast aluminum, type FD, with gasketed cover.
- E. Refer to the drawings for floor box type(s) and configuration(s).
- F. Enclosures and cabinets shall comply with the following unless otherwise noted on the drawings:
 - 1. Constructed of galvanized steel.

2. Finished inside and out with manufacturers standard enamel.
3. Continuous hinged cover.
4. Flush latch keyed to match panelboards.
5. Provide accessory feet where freestanding.

2.9 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. Acceptable Manufacturers:
 1. Armorcast Products Company.
 2. Quazite, Hubbell.
 3. Old Castle Pre-Cast, Inc.
- B. Provide handholes and boxes with the following general requirements unless otherwise noted on the drawings:
 1. Constructed of polymer-concrete, molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
 - a. Provide minimum TIER 22 rating.
 2. Color to be selected during shop drawing review.
 3. Units shall be designed for flush burial, have open bottom and gasketed.
 4. The cover shall be gasketed, secured by tamper-resistant locking devices and provided with a nonskid finish (minimum coefficient of friction of 0.50).
 5. Covers shall be provided with molded lettering identifying the service for which the box is used. Examples: "ELECTRIC", "TELEPHONE" or other.
 6. Minimum size shall be 18 inches x 30 inches and 24 inches deep.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Where surface raceways are permitted to be installed by the contract documents, coordinate installation with architectural drawings including windows, furniture, display boards, etc.
- B. Coordinate the installation of raceways, boxes, etc. with all other trades.
 1. Install horizontal raceways above water and steam piping.
 2. Maintain a minimum of 6 inches of separation between raceways and steam, flues, and hot-water pipes.
- C. Provide protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

3.2 INSTALLATION

- A. General Requirements
 1. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on the drawings or in this article are stricter.
 2. All conduit, raceways, boxes, etc. shall be installed concealed unless noted otherwise on the drawings or listed in the following exceptions:
 - a. In dedicated electrical or mechanical rooms/spaces.
 - b. Located in ceiling spaces with exposed structure.

- c. Existing inaccessible walls.
 - 1) FMC shall be fished/installed within CMU walls where the cells have not been filled with concrete.
- 3. Do not fasten conduits onto the bottom side of the roof deck.
- 4. Install raceways parallel or perpendicular to building lines.
- 5. All items shall be wet location rated when installed in wet locations.
- 6. Install no more than the total of 270 degree of bends in any conduit run, prior to installing a pull box, except for conduits/raceways containing voice/data and audio/visual cabling which require less.
- 7. Comply with the following for raceways containing voice/data and audio/visual cabling:
 - a. Install raceways in maximum lengths of 75 feet, with a maximum of 180 degree of bends, prior to installing junction or pull boxes.
 - b. Install insulating bushings on all raceways:
 - 1) Install push-on, non-metallic, insulating, plenum-rated, bushings on all unterminated raceways.
 - 2) Install insulated throat box connectors where raceways are terminated in outlet boxes, junction/pull boxes, cabinets, enclosures, etc.
 - 3) Install insulated throat, grounding bushings on metallic conduits and sleeves entering communication closets.
- 8. Label all junction box covers with black permanent marker, identifying the circuit numbers contained within.
- 9. Complete raceway installation before starting conductor installation.
- 10. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- 11. Raceways shall not be embedded in slabs unless explicitly noted to do so on the drawings. If raceways are noted to be embedded in slabs, comply with the following:
 - a. Run conduits parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - b. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - c. Change from RNC to rigid steel conduit or EMT, as applicable, before rising above the floor.
- 12. Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- 13. Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG, for terminations at locations subject to moisture or vibration.
- 14. RSC shall be terminated into threaded hubs or with locknuts on the inside and outside of boxes or cabinets.
 - a. Provide insulated throat bushings for RSC terminated with locknuts.

15. Install pull strings in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb. (90-kg) tensile strength. Leave at least 12 inches of slack at each end of pull strings.
16. Install raceway sealing fittings at suitable, approved, and accessible locations 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 at the following points:
 - a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces
 - b. Where otherwise required by NFPA 70.
17. For recessed boxes in masonry wall, saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.
 - a. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
18. Support boxes from building structure. Do not support boxes from conduit.
19. 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 grounding path.

B. Conductors

1. Conductors shall be installed in raceway in all locations unless otherwise noted.
2. Where cord drops and portable appliance connections are indicated on the drawings, provide stainless steel wire mesh strain relief at terminations to suit application.
3. All new line voltage wiring shall conform to the following color schemes. The insulation shall be as furnished from the factory for all conductor sizes. Phase taping will not be permitted.
 - a. 120/208- or 120/240-Volt Systems
 - 1) Phase A – Black
 - 2) Phase B – Red
 - 3) Phase C – Blue
 - 4) Neutral – White
 - 5) Ground – Green
 - b. 277/480 Volt Systems
 - 1) Phase A – Brown
 - 2) Phase B – Orange
 - 3) Phase C – Yellow
 - 4) Neutral – Gray
 - 5) Ground – Green
4. 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.

5. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
 6. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
 7. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified by UL.
 8. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 9. Install conductors at each outlet with at least 6 inches of slack.
 10. Where conductors are oversized (such as for voltage drop), provide conductor reducers or other approved wire reduction method as required for termination at the respective equipment.
- C. Interior, above grade locations shall comply with the following:
1. All raceways shall be EMT unless otherwise noted below or on the drawings.
 - a. When the use of surface raceway (Wiremold) is permitted by the contract documents, it shall be installed in finished areas/spaces.
 - b. Provide flexible metallic conduit connections for the following:
 - 1) Recessed and semi-recessed lighting fixtures. Use a maximum of 72 inches for connections.
 - 2) For equipment subject to vibration, noise transmission or movement and for transformers and motors. Use a maximum of 36 inches.
 - 3) Use LFMC in damp or wet locations.
 - c. MC cable
 - 1) Locations permitted:
 - i) Concealed within metal or wood stud walls.
 - ii) Concealed above finished ceilings.
 - iii) 8 feet above finished floor and higher where exposed in unfinished spaces.
 - 2) MC cable shall only be permitted for single circuits up to #10 AWG.
 - 3) The MC cable shall transition to other specified raceways where it exits permitted locations.
 - 4) Provide cable with insulated bushings at terminations.
 - d. Where raceways are exposed and subject to physical damage, RSC shall be installed.
 - 1) Locations where raceways are subject to physical damage include mechanical equipment rooms, penthouses, platforms, mezzanines and loading docks. RSC shall be installed 8 feet above finished floor and below in these locations.
 - 2) RSC shall be installed in corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.

- 3) Boxes shall be cast metal.
2. All boxes shall be steel.
3. All enclosures shall be NEMA Type 1 unless otherwise noted on the drawings.
- D. Below grade locations shall comply with the following:
 1. All raceways shall be RNC, schedule 40, unless otherwise noted on the drawings.
 2. Transition from RNC to EMT at the point the conduit rises above the slab. Transition from RNC to RSC before the conduit rises above the finished grade for exterior locations.
 3. All cabling or conductors installed in raceway below grade shall be rated for wet locations.
- E. Exterior, above grade locations, where permitted by the contract documents to be exposed, comply with the following:
 1. All raceways, boxes, enclosures, conductors, cabling, etc. shall be wet location rated. Any fittings shall be watertight.
 2. All raceways shall be RSC with threaded connections unless otherwise noted on the drawings.
 - a. Raceways shall be painted battleship gray unless otherwise noted on the drawings.
 3. All boxes shall be cast metal.
 4. All enclosures shall be NEMA Type 3R unless otherwise noted on the drawings.
- F. Underground Conduit
 1. General requirements
 - a. All raceways installed underground, outside the building footprint, shall be buried a minimum of 30 inches below grade unless otherwise noted on the drawings.
 - b. All raceways installed below the slab within the building footprint, may be installed directly below the slab.
 - c. Install manufactured elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise noted on the drawings.
 - d. Multiple raceways may be installed in the same trench. Where this occurs, provide spacers on raceways as required to maintain a minimum of three (3) inches of separation between raceways. Install spacers at a maximum of five (5) feet intervals.
 - e. Where raceways are noted to be encased in concrete on the drawings or elsewhere in this specification, they shall be encased in a minimum of 3 inches of concrete, around all sides.
 - 1) Install conduit supports at a maximum of five (5) feet intervals.
 - 2) Multiple raceways may be installed in the same concrete encasement. Provide spacers on raceways as required to maintain a minimum of three (3) inches of separation between raceways. Install spacers at a maximum of five (5) feet intervals.
 - 3) Use a minimum of 3500 psi ready-mix concrete.
 2. Excavation and Backfill

- a. Excavate trenches to indicated gradients, lines, depths, and elevations.
- b. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
- c. Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Remove projecting stones and sharp objects along trench subgrade.
- d. Where concrete encasement is required, excavate trenches a minimum of 3 inches deeper than bottom of pipe and conduit elevations to allow for concrete encasement. Hand-excavate deeper for bells of pipe.
- e. Trenches in Tree- and Plant-Protection Zones shall comply with the following:
 - 1) Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 - 2) Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
- f. Backfill shall comply with the following:
 - 1) Place and compact backfill of satisfactory soil in layers of no more than 8 inches, free of particles larger than 1 inch in any dimension to final subgrade elevation. Place backfill on subgrades free of mud, frost, snow, or ice.
 - 2) Where concrete encasement is required, install on subgrades free of mud, frost, snow, or ice. Place backfill on concrete encasement only after concrete has cured.
- g. Install detectable warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

G. Underground Handholes and Boxes

- 1. Install level and plumb. In paved areas, install so the cover is flush with finished grade. In other areas, install so the cover is a maximum of 1-inch above finished grade.
- 2. Raceways shall turn up from the bottom, approximately 12 inches above gravel bottom. Seal conduits with duct seal putty or foam.
- 3. Install per the manufacturer's recommendations. Comply with the following at a minimum:
 - a. Excavate 6-8 inches deeper and 1-2 feet wider than the dimensions of the enclosure and fill with gravel or crushed rock for drainage.
 - b. Provide internal bracing.

END OF SECTION 26 05 33

SECTION 26 05 36 – CABLE TRAYS

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to the general requirements specification, Section 26 05 00.
- B. This Section includes, but not limited to, the following:
 - 1. Basket cable tray
 - 2. Cable/Ladder runway
 - 3. Accessories
- C. The term 'cable tray' is used interchangeably to describe either wire basket tray or ladder runway.

1.2 SCOPE

- A. Provide cable tray for the support of low voltage cabling as indicated on the drawings and described within this specification.
- B. All miscellaneous items and accessories required for a complete cable tray system shall be provided whether or not each item is explicitly mentioned in these specifications or shown on the contract drawings.
- C. Seismic
 - 1. Refer to the structural drawings and specifications for seismic design requirements.
 - 2. Refer to the Vibration and Seismic Controls for Electrical Systems specification, section 26 05 48 for additional requirements.
 - 3. The specified work in this section must withstand the seismic hazard design loads for installed elevation above and below grade.
 - a. The term 'withstand' means 'unit must remain in place without separation of parts from unit when subjected to specified seismic design loads.'

1.3 SUBMITTALS

- A. Product Data
 - 1. Provide the manufacturer's product data sheets for each component to be utilized on this project. Provide dimensions and finishes for each type of cable tray and accessory.
- B. Seismic Performance Certificates
 - 1. Provide certificates for cable tray system, accessories, and components, from manufacturer. Include the following information:
 - a. Basis for Certification
 - 1) Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outlined Drawings of Equipment Unit:
 - 1) Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

1.4 OPERATION AND MAINTENANCE MANUALS

- A. Provide functional test results.

1.5 QUALITY ASSURANCE

- A. All equipment supplied for this system shall be the product of a single manufacturer, unless specifically noted otherwise.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers
 - 1. Chalfant Manufacturing Company
 - 2. Cooper B-Line, Inc.
 - 3. Cope, T. J., Inc.; a subsidiary of Allied Tube & Conduit
 - 4. MONO-SYSTEMS, Inc.
 - 5. MPHusky
 - 6. Cablofil
 - 7. Southwest Data Products (Ladder Rack Only)
 - 8. Chatsworth
 - 9. Snake Tray

2.2 WIRE BASKET CABLE TRAY

- A. UL Classified as an equipment grounding conductor.
 - 1. Splicing assemblies shall be UL Classified as an equipment grounding conductor.
- B. Construction
 - 1. 12"Wx4"D
 - 2. Rounded edges and smooth surfaces.
 - 3. Minimum wire diameter shall be .196" on all mesh sections.
 - 4. All straight section longitudinal wires shall be constructed with a continuous top wire safety edge. Safety edge must be kinked and T-welded on all tray sizes.
 - 5. Wire mesh pattern with intersecting wires welded together.
 - 6. All mesh sections must have at least one bottom longitudinal wire along the entire length of the straight section.
 - 7. Steel, meeting the minimum mechanical properties of ASTM A510, Grade 1008. Hot dipped galvanized after fabrication.

2.3 CABLE/LADDER RUNWAY

- A. UL Classified as an equipment grounding conductor.
 - 1. Splicing assemblies shall be UL Classified as an equipment grounding conductor.
 - 2. Paint must be removed prior to splice connection.
- B. Construction
 - 1. 18"W, 2" tall side rails, rungs 9" on center.

2. Two longitudinal side rails with transverse rungs.
3. 1" rungs welded to side rails.
4. Rectangular steel tubing.
5. Flat black powder coat painted.

2.4 FITTINGS AND ACCESSORIES

- A. All fittings, supports, splices, etc. for the cable tray systems shall be provided as required for a complete assembly.
- B. Tees, crosses, risers, elbows, and other fittings shall be of the same materials as the cable tray.
- C. Supports and connectors, including bonding jumpers, as recommended by the manufacturer.
- D. Divider Wall
 1. Used to separate cables within came cable tray.
 2. Steel, Hot dipped galvanized after fabrication.
 3. Washer and bolt connection to cable tray.
 4. Height same as depth of cable tray.
- E. Radius Shields
 1. Provides a smooth radius/corner around junctions.
 2. Polycarbonate material.
 3. Slick surface to reduce cable friction.
 4. Toolless installation.
- F. Cable Exit Clip/Dropout Waterfalls
 1. Maintains a proper bend radius for cables that transition down from cable tray.
 2. Snap-on
 3. Steel, Hot dipped galvanized after fabrication.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate installation of cable tray and accessories with the cable installers for Divisions 23, 27 and 28 contractors.
- B. The drawings indicate the general route of the cable tray system. Field verification of all dimensions, routing, coordination with other trades, etc. is required prior to installation.

3.2 INSTALLATION

- A. Prior to Installation
 1. Unpack and dry wet materials before storage.
 2. Store indoors to prevent water or other foreign materials from staining or adhering to cable tray.
- B. Cable Tray
 1. Install in accordance with the manufacturer's recommendations.
 2. Comply with recommendations in NEMA VE 2 and ANSI/EIA/TIA 569A.

3. Install cable tray as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, hinged horizontal and vertical splice plates, elbows, reducers, tees, crosses cable dropouts, covers and bonding.
4. Install cable tray so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.
5. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed recommended dimensions. Space connectors and set gaps in accordance with applicable standard.
6. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.
7. Remove burrs and sharp edges from cable trays.
8. Fasten cable tray supports to building structure and install seismic restraints.
 - a. Fasteners and supports shall carry at a minimum the cable tray, cables, and a concentrated load of 200 pounds.
 - b. Place supports so that spans do not exceed the manufacturer's recommended maximum spans. Install intermediate supports when cable weight exceeds the load-carrying capacity of tray rungs.
 - c. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
 - d. Support assembly to prevent twisting from eccentric loading.
 - e. Do not install more than one cable tray splice between supports.
9. Locations
 - a. Cable/Ladder runway shall be installed within telecommunication rooms and other locations that may be indicated on the drawings.
 - b. Wire basket tray shall be installed outside telecommunication rooms unless otherwise noted on the drawings.
10. Penetrations Through Walls and Floor/Ceilings
 - a. Conduit sleeves shall be used to penetrate walls and floor/ceiling assemblies.
 - 1) The cable tray shall stop on either side of the wall or floor/ceiling assembly.
 - 2) Provide the quantity and size sleeves required to maintain a maximum 40% fill ratio. Provide one empty spare sleeve of the same size as the other sleeves.
 - b. Sleeves Penetrating Rated Assemblies
 - 1) Provide rated and re-penetrable cable pathway.
 - 2) The sleeve shall be rated for the assembly and environment in which it is installed.
11. Fittings and Accessories
 - a. Make changes in direction and elevation using standard fittings.
 - b. Make cable tray connections using standard fittings.

- c. Install radius shields where cable tray changes direction.
- d. Install dropouts where cable extends downward from tray.
- e. Install rubber caps at exposed ends of wire basket tray.
- f. Install divider wall to separate telecommunications (network) cabling from other types of cabling.

12. Grounding

- a. Ground and bond metal cable trays in accordance with NEC article 392 and the manufacturer's instructions.
- b. Metal cable trays shall be electrically continuous through approved connections or the use of a bonding jumper.

13. Protection

- a. Provide temporary protection for cable trays to safeguard against damage from falling objects or debris during construction.
- b. Provide temporary protection from painting during construction.
- c. Repair damage to galvanized finishes with zinc-rich paint recommended by the cable tray manufacturer.
- d. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

C. Cables

- 1. Install cables only when cable tray installation has been completed.
- 2. Cables shall be protected from painting during construction.
 - a. Painting of cables will void the cables' warranty.
 - b. Any painted cables will be required to be replaced at the contractor's expense.
- 3. Renovations
 - a. Remove inactive or abandoned cabling installed in existing cable trays.

3.3 FUNCTIONAL TESTING

- A. Test cable tray to ensure electrical continuity of bonding and grounding connections. There shall be a continuous electrical path to the electrical grounding system from any point on the telecommunications pathway. See NFPA 70B, Chapter 18, for testing and test methods.
 - 1. Report results in writing and include in the Operations and Maintenance Manuals.

END OF SECTION 26 05 36

SECTION 26 05 48 – SEISMIC AND WIND CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to General Requirements Specifications, Section 26 05 00.
- B. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Restraints - rigid type.
 - 3. Restraints - cable type.
 - 4. Restraint accessories.
 - 5. Post-installed concrete anchors.
 - 6. Concrete inserts.

1.2 SCOPE

- A. Provide positive seismic- and wind-load restraint in accordance with the requirements of this section in order to maintain the integrity of non-structural components of the building so they remain safe and functional in case of seismic and wind events.
- B. The design of the seismic- and wind-load restraints is delegated to the contractor. The design shall be prepared, signed, and sealed by a qualified structural professional engineer licensed in the state where the project is located.
- C. The following components/systems have a component importance factor of 1.5:
 - 1. Fire Alarm System
 - 2. Emergency Lighting
 - 3. Communication Equipment Frames
 - 4. Gymnasium and Football Sound Systems
 - 5. Intercom System
 - 6. Two-Way Communication

1.3 SUBMITTALS

- A. Provide product data for all products included in this scope of work.
 - 1. Provide performance data illustrating size, physical appearance and other characteristics of the products.
 - 2. Include rated load capacity for each seismic- and wind-load-restraint device.
 - 3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - 4. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by UL product listing or an agency acceptable to authorities having jurisdiction.
 - 5. Annotate to indicate application of each product submitted and compliance with requirements.
 - 6. The manufacturer of the equipment required to be restrained shall submit seismic performance certificates. Include the following:

- a. Basis for certification:
 - 1) Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned outline drawings of equipment unit:
 - 1) Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
 - d. Indicate the equipment is certified to be durable enough to:
 - 1) Structurally resist the design forces (non-essential equipment) and/or
 - 2) Will remain functional after the seismic event (essential equipment).
- B. Shop Drawings:
 - 1. Detail fabrication and assembly of equipment bases.
 - 2. Show coordination of seismic and wind-load bracing for components with other systems and equipment in the vicinity, including other supports and seismic restraints.
- C. Delegated Design Submittal for each Seismic-Restraint Device: Signed and sealed by qualified structural professional engineer.
 - 1. For each seismic-restraint device that is required by the contract documents, submit the following:
 - a. Seismic Restraints: Select seismic restraints complying with performance requirements, design criteria, and analysis data.
 - b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by qualified testing laboratory for seismic reinforcement use.
 - c. Seismic Design Calculations: Submit input data and loading calculations.
- D. Delegated Design Submittal for Each Wind-Load Protection Device: Signed and sealed by qualified structural professional engineer.
 - 1. For each wind-load protection device that is required by the contract documents, submit the following:
 - 2. Wind-Load Restraint: Select wind-load restraints complying with performance requirements, design criteria, and analysis data.
 - 3. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated wind loads. Include certification that device is approved by qualified testing laboratory for reinforcement use.
 - 4. Wind-Load Design Calculations: Submit static and dynamic loading calculations.
- E. Seismic- and Wind-Load-Restraint Detail Drawings: Signed and sealed by qualified structural professional engineer.
 - 1. Design Analysis: To support selection and arrangement of seismic and wind-load restraints. Include calculations of combined tensile and shear loads.
 - 2. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and

spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

3. Coordinate seismic-restraint details with wind-load details required for equipment mounted outdoors.

1.4 OPERATION AND MAINTENANCE MANUALS

- A. Provide test and inspection reports.

1.5 QUALITY ASSURANCE

- A. Product Listing, Preapproval, and Evaluation Documentation: By UL or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- B. All seismic and wind restraint systems shall be by a single manufacturer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Acceptable Manufacturers:
 1. Kinetics Noise Control, Inc.
 2. Approved equivalents.
- B. Refer to the Architectural and Structural drawings and specifications for site-specific seismic and wind load design criteria.
- C. Seismic- and Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: UL product listing or an agency acceptable to authorities having jurisdiction.
- D. Consequential Damage: Provide additional seismic and wind-load restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component will not cause failure of any other essential building component.
- E. Fire/Smoke Resistance: Seismic- and wind-load-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by qualified testing laboratory in accordance with ASTM E84 or UL 723, and be so labeled.
- F. Component Supports:
 1. Load ratings, features, and applications of reinforcement components must be based on testing standards of qualified testing laboratory.

2.2 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
 1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 2. Size: Factory or field cut to match requirements of supported equipment.
 3. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
 4. Surface Pattern: Non-slip pattern

5. Load-bearing metal plates adhered to pads.

2.3 RESTRAINTS - RIGID TYPE

- A. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.4 RESTRAINTS - CABLE TYPE

- A. Seismic- and Wind-Load-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.
- B. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. Cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.5 RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: Reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.6 POST-INSTALLED CONCRETE ANCHORS

- A. Mechanical Anchor Bolts:
 1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.
- B. Adhesive Anchor Bolts:
 1. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.
- C. Provide post-installed concrete anchors that have been prequalified for use in seismic and wind-load applications.
 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

2.7 CONCRETE INSERTS

- A. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC446 testing.
- B. Comply with MSS SP-58.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Install seismic and wind restraint devices per the manufacturer's requirements and applicable building codes.
 - 2. Isolated and restrained electrical systems located on roofs must be attached to the structure. Supports/sleepers that are not attached to the structure will not be acceptable.
 - 3. Do not brace or support equipment to separate portions of the structure that may act differently in response to an earthquake. For example, do not connect a Transverse restraint to a wall and then a longitudinal restraint to either a floor/ceiling/roof at the same braced location.
 - 4. Housekeeping Pads
 - a. Coordinate housekeeping pads supporting seismically rated equipment.
 - 1) Coordinate size, thickness, doweling, and reinforcing of concrete equipment housekeeping pads and piers with seismic restraint devices manufacturer to ensure adequate space, embedment and prevent edge breakout failures.
 - 2) Pads must be adequately reinforced and adequately sized for proper installation of equipment anchors.
- B. Seismic Restraint Application
 - 1. General:
 - a. Provide vertical braces to stiffen hanger rods and prevent buckling per seismic restraint manufacturer's design. Clamp vertical brace to hanger rods. Requirements apply equally to hanging equipment. Do not weld vertical braces to hanger rods.
 - 1) Rod stiffener clamps are required where the hanger rod exceeds the maximum length shown in the seismic calculation sheets. They are only required at restraint locations.
 - b. If a specific attachment for seismic restraint is not indicated for suspended electrical systems, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
 - 1) Seismic restraint connections are not be connected to the bottom chord of steel joists or the bottom flange of steel beams.
 - c. Seismically rated beam clamps are required where welding to or penetrations to steel beams are not approved.
 - d. Where rigid restraints are used on electrical systems, the support rods for the systems at restraint locations must be supported by anchors rated for seismic use. Post-installed concrete anchors must be in accordance with ACI 355.2.

- e. Adjust restraint cables so that there is no visible slack. The cable is not to support the weight during normal operation.
- f. Drilled or power driven anchors or fasteners shall not be permitted for use with seismic control measures.

2. Concrete Anchor Bolts:

- a. Identify the position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre- or post-tensioned tendons, electrical and telecommunications conduit, and gas lines.
- b. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
- c. Protect threads of mechanical anchors from damage during anchor installation.
- d. Adhesive anchors:
 - 1) Clean holes to remove loose material and drilling dust per manufacturer's instructions prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
- e. Set anchors to manufacturer's recommended torque, using a torque wrench.
- f. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3. Electrical systems:

- a. All electrical systems are to be restrained in accordance with the applicable building codes.
 - 1) All electrical systems assigned a component importance factor of 1.5 shall require seismic restraints.
 - 2) Electrical systems located in Seismic Design Categories D, E, F, assigned a component importance factor of 1, and do not meet the exemptions listed in the building code, shall require seismic restraints.
 - 3) All electrical systems that are exposed to wind (i.e. located exterior to the building and above grade) shall be restrained from the effects of wind.
- b. Equipment Restraints:
 - 1) Seismically restrain equipment indicated on the schedule. Install fasteners, straps and brackets as required to secure equipment.
 - 2) Install neoprene grommet washers or fill gap with epoxy on equipment anchor bolts where clearance between anchor and equipment support hole exceeds .125 inches.
 - 3) Rigid mounted equipment:
 - a) Anchor floor and wall mounted equipment to the structure as per the stamped seismic certifications/drawings.

- b) Suspended equipment shall be restrained using seismic cable restraints, or struts, and hanger rods as per the stamped seismic certifications/drawings.
- c. Seismically restrain all electrical components listed below, unless otherwise indicated on the drawings, using seismic cable restraints:
 - 1) Seismically restrain all conduit 2.5 inches in diameter and larger.
 - 2) Seismically restrain all conduit, bus ducts, or cable trays that are supported on trapeze bars, and that have a total weight greater than 10 lb/ft. This total weight includes not only the conduit, bus duct, or cable trays, but also includes the trapeze bars as well.
 - a) It is necessary for the conduit, bus ducts, and cable trays to be attached to the trapeze bars sufficiently to resist the design horizontal seismic forces, both traverse (T) and longitudinal (L). Secure with clamps approved for the application.
- d. Cable trays:
 - 1) Cables installed in cable tray shall be strapped either individually or in bundles to the cable tray at regular intervals to ensure that the seismic forces are transferred properly to the restraint points.
- e. Brace a change in direction longer than 12 feet.
- f. Install restraint cables so they do not bend across edges of adjacent equipment or building structure. Tie back to structure at 45 degrees to structure.
- g. Longitudinal restraints for single conduit support shall be attached rigidly to the conduit, not the conduit hanger.
- h. Where conduit, bus ducts, cable tray sizes reduce below required dimensions noted in 3.1, B, 4, b, the final restraint shall be installed at the transition location.
- i. Install flexible connectors where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.2 FUNCTIONAL TESTING

- A. Provide special inspections as required by the building code.
- B. Refer to the architectural and structural drawings and specifications for required testing and inspections.

END OF SECTION 26 05 48

SECTION 26 05 53 – IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to the general requirements specification, Section 26 05 00.
- B. 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. Equipment identification labels.
 - 7. Miscellaneous identification products.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- 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 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.
- C. 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 adhesive tape for securing ends of legend label.
 - D. 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.
 - E. 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.

2.2 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 raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Snap-Around Labels: 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.
- D. Snap-Around, Color-Coding Bands: 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.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Snap-Around Labels: 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.
- D. Snap-Around, Color-Coding Bands: 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.

2.4 FLOOR MARKING TAPE

- A. 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.5 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.
- 2.6 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 grommets in corners for mounting.
 3. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs:
1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
 2. 1/4-inch grommets in corners for mounting.
 3. Nominal size, 10 by 14 inches.
- 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 36 INCHES."
- 2.7 EQUIPMENT IDENTIFICATION LABELS
- A. Engraved, Laminated Acrylic: Punched or drilled for screw mounting. White letters on a black background. Minimum letter height shall be 3/8 inch.
- 2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS
- A. Paint: Comply with requirements in Division 09 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. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- E. 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 maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- G. 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.
- H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
- I. Painted Identification: Comply with requirements in Division 09 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. Power.
- B. Power-Circuit Conductor Identification, 600 V or Less: Refer to Specification Section 260533 Raceways, Boxes, Power Conductors and Cables.
- C. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- D. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 - 1. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- E. 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.
- F. 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-high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. 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. Switchboards.
 - e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - f. Enclosed switches.
 - g. Enclosed circuit breakers.
 - h. Enclosed controllers.
 - i. Variable-speed controllers.
 - j. Push-button stations.
 - k. Contactors.
 - l. Remote-controlled switches, dimmer modules, and control devices.
 - m. Battery-inverter units.
 - n. Battery racks.
 - o. Power-generating units.
 - p. Monitoring and control equipment.
 - q. UPS equipment.

END OF SECTION 26 05 53

SECTION 26 05 73 – POWER SYSTEM STUDY

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to the General Requirements Specification, Section 260500.
- B. Section includes the requirements for a power system study consisting of a short-circuit, coordination and arc-flash hazard analysis.

1.2 SCOPE

- A. The contractor shall furnish short-circuit and arc-flash hazard analysis studies.
- B. The study is to include all new equipment shown and specified in the contract documents including switchgear, switchboards, panels, motor control centers, transformers, generators, transfer switches, motors 50 horse power and larger, safety disconnects, and other locations likely to require examination, adjustment, servicing, or maintenance while energized. The study is to include existing electrical distribution equipment which feeds new equipment. The contractor or contractor's representative shall collect field data in order to include the existing equipment which feeds new equipment. Existing equipment which does not feed new equipment is not included in the scope of the study.

1.3 SUBMITTALS

- A. Report
 - 1. The studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. When completion of the full study is not possible due to missing information and when the completion of the study is needed to avoid delays in equipment shipments, assumptions may be made, and the contractor shall complete a preliminary study. If formal completion of the study may cause delays in equipment shipments, approval from the Engineer may be obtained for a preliminary submittal of data to ensure that the selection of device ratings and characteristics will be satisfactory to properly select the distribution equipment.
- B. Labels
 - 1. Provide example arc-flash labels.

1.4 OPERATIONS AND MAINTENANCE MANUALS

- A. The results of the short-circuit and protective device coordination studies shall be summarized in a final report. Electronic PDF copies of the report shall be provided. One (1) bound and printed copy shall be included in the operations and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. The short-circuit studies shall be conducted under the responsible charge and approval of a Registered Professional Electrical Engineer, licensed in the state where the project is located, skilled in performing and interpreting the power system studies.
- B. The Registered Professional Electrical Engineer shall be an employee of the equipment manufacturer or an approved engineering firm.
- C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.
- D. Computer Analysis Software

1. The studies shall be performed using SKM Systems Analysis Power*Tools for Windows (PTW) software, EasyPower software, ETAP PS software, or an approved equivalent software. SKM Systems Analysis Power*Tools for Windows (PTW) is the preferred software.

PART 2 - PRODUCTS

2.1 STUDIES

- A. The contractor shall furnish short-circuit and arc-flash hazard analysis studies.

2.2 DATA

- A. Contractor shall furnish all data as required for the power system studies. The Engineer performing the short-circuit studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
- B. Fault contribution may include present and future motors and generators.
- C. Load data utilized may include existing and proposed loads obtained from the Contract Documents.
- D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 SHORT-CIRCUIT ANALYSIS

- A. Transformer design impedances shall be used when test impedances are not available.
- B. Provide the following:
 1. Calculation methods and assumptions
 2. Selected base per unit quantities
 3. One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis
 4. The study shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
 5. Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating.
 6. Results, conclusions, and recommendations. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.
- C. For solidly-grounded systems, provide a bolted line-to-ground fault current study for applicable buses as determined by the engineer performing the study.
- D. Protective Device Evaluation:
 1. Evaluate equipment and protective devices and compare to short circuit ratings

2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
3. Contractor shall notify the Engineer in writing, of any circuit protective devices improperly rated for the calculated available fault current.

2.4 ARC- FLASH HAZARD ANALYSIS

- A. The analysis shall be performed in compliance with the latest versions of NFPA 70E, IEEE Standard 1584 and IEEE Standard 1584.1.
- B. The analysis shall consider multiple possible system configurations where appropriate such as normal and emergency transfer switch positions and different main-tie-main configurations. Clearly describe and list the different system configurations included in the analysis.
- C. The Arc-Flash Hazard Analysis shall include recommendations for reducing Arc-Flash Incident Energy (AFIE) levels and enhancing worker safety.
- D. Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form and shall include the following information for each bus location:
 1. Equipment/bus name.
 2. Protective device name.
 3. Bus voltage.
 4. Bolted fault current.
 5. Arcing fault current.
 6. Trip/delay time.
 7. Equipment type.
 8. Working distance.
 9. Arc-flash boundary.
 10. Arc-flash hazard incident energy.
- E. Arc-flash labels shall be supplied and installed.
 1. Produce a 3.5 by 5 inch self-adhesive equipment label for each work location included in the analysis.
 2. Labels shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD" or similar. The labels shall include the following information taken directly from the arc-flash hazard analysis:
 - a. Location designation.
 - b. Nominal voltage.
 - c. Protection boundaries.
 - (1) Arc-flash boundary.
 - (2) Restricted approach boundary.
 - (3) Limited approach boundary.
 - d. Available incident energy.
 - e. Working distance.
 - f. Engineering report number, revision number, and issue date.

3. Labels shall be machine printed, with no field-applied markings. The label shall be of sufficient durability to withstand the environment involved.

PART 3 - EXECUTION

3.1 REPORT

- A. The final report shall include the following sections:
 1. Executive Summary including Introduction, Scope of Work and Results/Recommendations.
 2. Short-Circuit Methodology, Analysis, Results and Recommendations
 3. Short-Circuit Device Evaluation Table
 4. Protective Device Settings Table
 5. Arc-Flash Hazard Analysis Methodology, Results and Recommendations
 6. Arc-Flash Hazard Analysis Table
 7. One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, and other information pertinent to the computer analysis.

3.2 INSTALLATION

- A. Field Adjustment
 1. Contractor shall adjust relay and protective device settings according to the recommended settings table. Contractor shall be qualified and experienced in adjusting protective device settings.
 2. Contractor shall make modifications to equipment as required to accomplish conformance with short circuit studies.
- B. Labels
 1. The Contractor shall label the service equipment with the maximum available fault current. The label(s) shall include the date the fault current calculation was performed.
 2. The Contractor shall provide and install arc-flash labels on all equipment included in the study as described in section 2.5.

END OF SECTION 26 05 73

SECTION 26 09 23 – LOW VOLTAGE LIGHTING CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to the general requirements specification, Section 26 05 00.
- B. This section includes items pertaining to the lighting control system (LCS), including but not limited to the following:
 - 1. Sensors
 - 2. Switches
 - 3. Power Packs/Relays
 - 4. Cable
 - 5. Power supplies

1.2 SCOPE

- A. Provide a hard-wired, non-networked, lighting control system (LCS).
 - 1. The lighting control zones shall be standalone and operate individually.
 - 2. All LCS components shall be network capable for future flexibility to add to a lighting control network.
- B. Provide a complete and operational system as described within this specification and as shown on the drawings.
- C. All miscellaneous items and accessories required for a complete and operational system shall be provided whether or not each item is explicitly mentioned in these specifications or shown on the contract drawings.
 - 1. The contractor is responsible for providing all line voltage circuits necessary for the operation of the system.
- D. Seismic
 - 1. Refer to the structural drawings and specifications for seismic design requirements.
 - 2. Refer to the Seismic and Wind Controls for Electrical Systems specification, section 26 05 48 for additional requirements.
 - 3. The specified work in this section must withstand the seismic hazard design loads for the installed elevation above and below grade.
 - a. The term 'withstand' means 'unit must remain in place without separation of parts from unit when subjected to specified seismic design and unit must be fully operational after seismic event'.

1.3 SUBMITTALS

- A. Product Data
 - 1. Provide the manufacturer's product data sheets for each component to be utilized on this project.
 - 2. Provide images of proposed custom button labeling for switches in each zone.
- B. Shop Drawings
 - 1. Provide riser diagrams showing the interconnectivity of devices for each lighting control zone.

2. Provide drawings showing the location and type of each device overlaid on the floor plan.
- C. Provide an example Contractor Startup/Commissioning Worksheet
- D. Seismic Performance Certificates
 1. Provide certificates for the equipment and accessories, from the manufacturer. Include the following:
 - a. Basis for Certification
 - 1) Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outlined Drawings of Equipment
 - 1) Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

1.4 OPERATION AND MAINTENANCE MANUALS

- A. Provide functional test results and certifications.
- B. Provide contact information. The contact information shall include names, physical addresses, phone numbers and email addresses of the following:
 1. Installing company
 2. Specific contact person(s) for technical assistance, service and maintenance.
 3. Emergency contact information for after-hours technical assistance, service and maintenance.
- C. Provide a copy of the owner training sign-in sheet.
- D. Provide a digital copy of the recording from the owner training session.
- E. Provide a copy of the manufacturer's warranty.
- F. Provide a complete material and equipment list with corresponding part/model numbers.
- G. Provide an operation/user manual detailing operating instructions, programming instructions, maintenance requirements and trouble-shooting procedures.
- H. Provide as-built drawings. These drawings shall include the following at a minimum:
 1. Indicate the location of all LCS components.
 2. Indicate the load controlled by each relay and the electrical circuit number connected to each relay.
 3. Document all programmed settings associated with each device.

1.5 QUALITY ASSURANCE

- A. All components and the manufacturing facility where the products were manufactured must be ROHS compliant.
- B. When LCS components are installed in high humidity or cold environments, they shall be conformably coated and rated for condensing humidity and -40 degree Fahrenheit operation.

1.6 WARRANTY

- A. The manufacturer shall warranty and agree to repair or replace all components that fail due to defects in material or workmanship for a period of 5 years starting from the date of substantial completion.
 - 1. The contractor shall be responsible for repairing or replacing all components that fail within one year of the date of substantial completion. The contractor will be financially responsible for the cost of material and labor for this period.
 - 2. The remainder of the warranty period shall apply to material costs only. Labor costs are excluded after the first year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. nLight (Basis of Design)
- B. Cooper
- C. WattStopper

2.2 SYSTEM REQUIREMENTS

- A. Refer to the drawings for lighting control details, zone control/sequences of operation, and other lighting control requirements.
- B. System shall have an architecture that is based upon two main concepts: 1) intelligent lighting control devices 2) standalone lighting control zones.
- C. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations.
- D. Intelligent lighting control devices shall communicate digitally and possess RJ-45 style connectors.
- E. Lighting control zones shall consist of one or more intelligent lighting control components.
 - 1. Devices within a lighting control zone shall be connected with a minimum category 5e UTP cable in any order.
 - 2. The Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.
 - 3. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes.
 - 4. Individual lighting zones shall be capable of being segmented into several "local" channels of occupancy, photocell, and switch functionality for more advanced configurations and sequences of operation.

2.3 INDIVIDUAL DEVICE SPECIFICATIONS

- A. System Occupancy Sensors
 - 1. Occupancy sensors system shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
 - 2. Passive Infrared Sensors (PIR) shall utilize passive infrared technology, which detects occupant motion.
 - 3. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics or ultrasonic.

4. Provide sensors with one or two occupancy “poles” as indicated on the drawings. Each pole shall provide a programmable time delay.
 5. Provide sensors with a lens best suited for the environment in which it is installed.
 6. Communication and Class 2 low voltage power shall be delivered to each device via standard category 5e UTP cabling with RJ-45 connectors.
 7. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.
 8. All sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate of a potential wiring issue
- B. System Digital Timeclock
1. nLight nDTC
 2. Provides scheduling, dimming, switching, occupancy and photosensing for the wired network.
 3. Controls up to 32 schedules and 127 nLight devices.
 4. Astronomical Timeclock with programmable latitude and longitude.
 5. 3.5” full-color responsive capacitive touch screen.
- C. System Daylight (Photocell and/or Dimming) Sensors
1. Photocell shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
 2. Photocell and dimming sensor’s set-point and deadband shall be automatically calibrated through the sensor’s microprocessor by initiating an “Automatic Set-point Programming” procedure. Min and max dim settings as well as set-point may be manually entered.
 3. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
- D. System Power (Relay) Packs
1. Power Pack shall incorporate one or more Class 1 relays and contribute low voltage power to the rest of the system.
 - a. Secondary Packs shall incorporate relay(s), shall have an optional 2nd relay, 0-10 VDC dimming output, or line voltage dimming output, but shall not be required to contribute system power.
 - b. Power Supplies shall provide system power only but are not required to switch line voltage circuit.
 - c. Auxiliary Relay Packs shall switch low voltage circuits only.
 2. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.
 3. All devices shall have two RJ-45 ports.
 4. Every Power Pack parameter shall be available and configurable locally via the device push-button.

5. Power Pack shall securely mount to a junction box through a threaded ½ inch chase nipple. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads.
 6. Emergency Power/Secondary Packs shall be UL924 listed for switching of Emergency Power circuits.
- E. Auxiliary Input / Output (I/O) Devices
1. Devices shall be plenum rated and have an extended chase nipple for mounting to a ½" knockout.
 2. Devices shall have two RJ-45 ports
 3. Communication and low voltage power shall be delivered to each device via standard category 5e UTP cabling with RJ-45 connectors.
- F. System Wall Switches & Dimmers
1. Devices shall recess into single-gang switch box and fit a standard Decora opening.
 2. Communication and low voltage power shall be delivered to each device via standard category 5e UTP cabling with RJ-45 connectors.
 3. All sensors shall have two RJ-45 ports.
 4. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
 - a. Provide push-buttons with custom button labeling.
- G. System Graphic Wall Station
1. Capacitive touchscreen wall switch. Enables control of nlight enabled devices, scenes, shades, and channels.
 2. Device shall surface mount to switch box.
 3. Device shall have two RJ-45 ports for communication
- 2.4 MISCELLANEOUS
- A. Device colors will be selected by the Architect during shop drawing review.
- PART 3 - EXECUTION
- 3.1 COORDINATION
- A. Coordinate functional testing of this system with the 3rd party commissioning authority. Refer to Specification Section 26 05 01, General Commissioning Requirements for requirements.
- 3.2 INSTALLATION
- A. The control system shall be installed and wired as shown on the plans, as described within this specification and according to the manufacturer's recommendations.
- B. Cabling
1. Cabling shall be installed in a similar manner as communication cabling. Refer to specification sections Raceways, Boxes, Power Conductors and Cables 260533; Communications Equipment Room 271100, Voice and Data Communications Cabling 271500 and the contract drawings for additional information.
 - a. All cabling shall be installed in a minimum 3/4" conduit.

- 1) Cabling may be installed in open-air where located above concealed, accessible ceiling spaces.
 2. Cabling shall not be installed on or through the ceiling structure.
 3. Splicing of cable is not permitted except in terminal cabinets and equipment housing.
- C. Power Packs
1. Label power packs, and similar devices, with the line voltage circuit number(s) connected to the power pack.
 - a. If power packs are located in a space with multiple controlled zones, label the zone which the power pack controls.
 - b. Label power packs with self-laminating adhesive labels.
 2. Locate power packs within the space they serve, above accessible ceilings.
 - a. If the space's ceiling is inaccessible, install above the nearest adjacent space that has accessible ceilings.
 - 1) Label the power pack with the room number it serves.
 - b. Locate power packs serving exterior circuits adjacent to the electrical panel feeding the exterior circuit.
 - 1) Label the power pack with the load being served, EX. 'Exterior Pole Lights.'
- D. Refer to the drawings for the zone control and sequences of operation.
- E. Mounting
1. Install per the manufacturer's instructions.
 2. Refer to specification sections, 262776 Wiring Devices, and 260533 Raceways, Boxes, Power Conductors and Cables for mounting requirements of boxes, switches, etc.
 3. Mount sensors a minimum of 4' away from HVAC vents.
 4. Sensors shall be mounted to an electrical box, not directly to ceiling tile or drywall.

3.3 FUNCTIONAL TESTING

- A. Commissioning of the lighting control system will be provided by a 3rd party. Refer to Specification Section 26 05 01, General Commissioning Requirements for additional information.
- B. A factory trained technician shall provide start-up and on-site commissioning. The technician shall inform the Engineer when the system is completely operational so the Engineer can conduct an inspection prior to the owner training. The technician shall be present during the Engineer's inspection.
- C. The LCS manufacturer's technician shall conduct a pre-installation meeting with the electrical contractor.

3.4 OWNER TRAINING

- A. Owner training shall not occur until the system is fully operational, software programmed, and all punch list items are completed. If 3rd party commissioning is provided for the project, the owner training shall not occur until the resolution tracking form is completed.

- B. The presenter/trainer shall be a manufacturer's authorized representative familiar with the system(s).
- C. The contractor shall provide the following at a minimum for owner training:
 - 1. Sign-in sheet documenting the attendees and presenter's names and contact information.
 - a. Include the date and time the training occurred.
 - 2. A copy of the operation manual for the system shall be provided to each attendee.
 - a. The operation manual shall be reviewed with the attendees in conjunction with the physical demonstration of the system.
 - 3. Eight (8) hours total of in-service training.
 - a. The training time shall be divided into a minimum of two segments occurring on separate days.
 - 4. The training shall be digitally recorded (audio and video). A copy of the recording shall be included with the O&M manual.

END OF SECTION 26 09 23

SECTION 26 22 13 – DRY-TYPE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to General Requirements Specification, Section 26 60 00.
- B. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.2 SUBMITTALS

- A. Product Data:
 - 1. Provide product data for each product to be used on this project.
 - a. Transformers – include the following information for each type and size transformer specified on the drawings.
 - 1) kVA
 - 2) Primary and secondary voltage
 - 3) Taps
 - 4) Design impedance
 - 5) Sound level/dB rating
 - 6) Insulation class and temperature rise
 - 7) Accessories provided
 - 8) Material descriptions
 - 9) Finishes
- B. Shop Drawings
 - 1. Provide drawings for each transformer to be used on this project. The drawings shall detail the equipment assembly indicating the following:
 - a. Dimensions
 - b. Weights
 - c. Required clearances
 - 2. Provide detail drawings of the assembly used for suspending and/or wall-mounting transformers.

1.3 OPERATION AND MAINTENANCE MANUALS

- A. Provide the manufacturer's written instructions for the installation, operation and routine maintenance requirements and recommendations.

1.4 QUALITY ASSURANCE

- A. All transformers provided for this project shall be the products of a single manufacturer obtained from a single source.
- B. All transformers shall be manufactured, listed, tested and installed in accordance with the applicable NEMA, IEEE, UL, ANSI and ASTM standards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers

1. Eaton/Cutler Hammer
2. General Electric/ABB
3. Square D; Schneider Electric
4. Siemens
5. Hammond Power Systems

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Provide general purpose distribution transformers unless otherwise noted on the drawings. K-factor rated transformers and shielded isolation transformers will be noted/designated on the drawings if required for the project. Refer to the drawings for voltage and kVA ratings.
- B. Transformers shall be factory assembled and tested, convection air-cooled units for 60 Hz service.
- C. Transformers shall be designed for continuous operation at rated kVA, for 24-hours a day, 365 days a year with normal life expectancy.
- D. Transformers shall have the following insulation system:
 1. Less than 15 kVA – 185 degree C with 115 degree C rise.
 2. Equal to or greater than 15 kVA – 220 degree C with 150 degree C rise.
 3. The required transformer performance shall be obtained without exceeding the above temperature rise in a 40 degree C maximum ambient, and a 24-hour average ambient of 30 degree C.
- E. Transformers must bear the UL Energy Efficiency Verification Mark to confirm the unit meets the requirements of the most current version of the federal law 10 CFR Part 431.
- F. Transformer sound levels shall not exceed the following ANSI and NEMA ratings:
 1. General purpose and K-factor = 1, 4, 9:
 - a. 9 kVA and less – 40 dBA
 - b. 10 kVA to 50 kVA – 45 dBA
 - c. 51 kVA to 150 kVA – 50 dBA
 - d. 151 kVA to 300 kVA – 55 dBA
 - e. 301 kVA to 500 kVA – 60 dBA
 - f. 501 kVA to 700 kVA – 62 dBA
 - g. 701 kVA to 1,000 kVA – 64 dBA
 2. K-factor = 13, 20
 - a. 9 kVA and less – 40 dBA
 - b. 10 kVA to 30 kVA – 45 dBA
 - c. 31 kVA to 50 kVA – 48 dBA
 - d. 51 kVA to 150 kVA – 53 dBA
 - e. 151 kVA to 300 kVA – 58 dBA
 - f. 301 kVA to 500 kVA – 63 dBA
 - g. 501 kVA to 700 kVA – 65 dBA
 - h. 701 kVA to 1,000 kVA – 67 dBA

- G. Transformer enclosures shall comply with the following unless otherwise noted on the drawings:
 - 1. Indoor locations
 - a. 15 kVA and below – NEMA 3R non-ventilated, totally enclosed.
 - b. Above 15 kVA – NEMA 2, ventilated.
 - 2. Exterior locations
 - a. 15 kVA and below – NEMA 3R, non-ventilated, totally enclosed.
 - b. Above 15 kVA – NEMA 3R, ventilated, with weather shields.
 - 3. Provide wiring compartment suitable for conduit entry and large enough for convenient wiring.
 - 4. The core shall be grounded to the enclosure.
 - 5. Provide with lifting provisions.
 - 6. Gray, weather-resistant enamel finish.
- H. The manufacturer shall paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.
- I. Provide transformers with the following taps:
 - 1. 15 kVA and Below – (2) 5% taps below rated voltage.
 - 2. Above 15 kVA – (2) 2.5% taps above and (4) 2.5% taps below.
- J. Provide with ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

2.3 GENERAL PURPOSE DISTRIBUTION TRANSFORMERS

- A. The core and core assembly shall comply with the following:
 - 1. Coils shall be wound of electrical grade aluminum or copper with continuous wound construction.
 - 2. Terminal connections shall be welded to the leads of the coils.
 - 3. The core shall be constructed with high-grade, non-aging, silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point.
 - 4. The core volume shall allow efficient transformer operation at 10% above the nominal tap voltage.
 - 5. The core laminations shall be tightly clamped and compressed.
 - 6. Transformers 15 kVA and below, the core and coil assembly shall be completely encapsulated in a proportioned mixture of epoxy or resin and aggregate to provide a moisture proof and shock resistant seal.
 - 7. Transformers above 15 kVA:
 - a. The coils shall be impregnated with a non-hygroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture.
 - b. The core shall be coated with HAPs (hazardous air pollutants) free water reducible electrical varnish for corrosion resistance.
 - c. The core and coil assembly shall be installed on vibration-absorbing pads.

2.4 SHIELDED ISOLATION TRANSFORMERS

- A. Shielded isolation transformers shall be provided with the same construction requirements as described for the general purpose distribution transformers, with the following exceptions:
 - 1. Provide electrostatic shielding consisting of a single turn of aluminum or copper between the primary and secondary winding and grounded to the housing of the transformer.

2.5 K-FACTOR RATED TRANSFORMERS

- A. K-factor rated transformers shall be provided with the same construction requirements as described for the general purpose distribution transformers, with the following exceptions:
 - 1. The core shall provide reduced induced currents in the steel caused by the high ratios of peak-to-rms currents and voltages found in harmonic loads.
 - 2. The neutral bus shall be configured to accommodate 200% of the rated current.
 - 3. Provide electrostatic shielding consisting of a single turn of aluminum or copper placed between the primary and secondary winding and grounded to the housing of the transformer.
 - 4. Indicate the K-factor value on the transformer nameplate.

2.6 IDENTIFICATION

- A. Provide engraved, laminated-acrylic or melamine plastic signs for each distribution transformer. Refer to the equipment identification detail on the drawings for additional information.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Equipment shall be handled and stored in accordance with the manufacturer's instructions.
 - 1. The manufacturer shall provide a minimum of one (1) copy with the equipment at the time of shipment.
- B. Enclosures shall be rated for the environment in which they are located.

3.2 INSTALLATION

- A. Install all equipment according to the manufacturer's recommendations and requirements.
- B. Mounting
 - 1. Transformers shall be floor-mounted unless otherwise noted on the drawings.
 - a. Provide a 4" tall, concrete base (housekeeping pad). Use a minimum of 3000-psi concrete with steel reinforcement. Refer to the 'Cast-in-Place Concrete', Division 3, specification for additional requirements.
 - b. Coordinate the size of the concrete base with the transformer being provided. The concrete base shall extend beyond the base of the transformer a minimum of 4 inches, or 10 anchor-bolt diameters, whichever is greater.
 - c. Anchor the transformer to the concrete base according to the manufacturer's instructions. Cast anchor-bolt inserts into concrete.
 - 2. Where transformers are indicated on the drawings to be wall-mounted or suspended from the structure:
 - a. Mount level and plumb.

- b. Provide wall brackets fabricated by the transformer manufacturer.
- C. Secure covers to the enclosure and tighten all bolts to the manufacturer-recommended torques.
- D. Remove shipping bolts, blocking, and wedges.
- E. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.3 FUNCTIONAL TESTING

- A. Provide the following standard factory tests on the equipment to be supplied for this project. All tests shall be in accordance with latest version of the ANSI and NEMA standards.
 - 1. Ratio tests at the rated voltage connection and at all taps.
 - 2. Polarity and phase relation tests on the rated voltage connection.
 - 3. Applied potential tests.
 - 4. Induced potential test.
 - 5. No-load and excitation current at rated voltage on the rated voltage connection.
- B. Provide the following field testing:
 - 1. Measure the primary and secondary voltages. Verify the correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
 - 2. Adjust the taps to deliver the appropriate secondary voltage.

END OF SECTION 26 22 13

SECTION 26 24 16 – PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to the general requirements specification, Section 26 05 00.
- B. 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. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Electronic-grade panelboards.

1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. SPD: Surge Protection Device.

1.4 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. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- C. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. 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.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. 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.
- 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 NEMA PB 1.
- E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 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 to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet .

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Architect and Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Architect and Owner's permission.
3. Comply with NFPA 70E.

1.8 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.
- 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 in Division 03.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.

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 Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.

- c. Kitchen Areas: NEMA 250, Type 1, stainless steel trim.
- 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
- 3. Finishes:
 - a. Panels and Trim: 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. Incoming Mains Location: Top and bottom.
- C. 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.
- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Mechanical type.
 - 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 - 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- E. 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.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker.

- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt on circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 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. Mains: Circuit breaker or lugs only as indicated on the drawings.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 ELECTRONIC-GRADE PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Current Technology; a subsidiary of Danahar Corporation.
 - 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 4. Liebert Corporation.
 - 5. Siemens Energy & Automation, Inc.
 - 6. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1; with factory-installed, integral TVSS; labeled by an NRTL for compliance with UL 67 after installing TVSS.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- F. Buses:
 - 1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
- G. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating complying with UL 1449, second edition, and matching or exceeding the panelboard short-circuit rating, redundant suppression circuits, with individually fused metal-oxide varistors.
 - 1. Accessories:
 - a. Fuses rated at 200-kA interrupting capacity.
 - b. Fabrication using bolted compression lugs for internal wiring.

- c. Integral disconnect switch.
 - d. Redundant suppression circuits.
 - e. Redundant replaceable modules.
 - f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - g. LED indicator lights for power and protection status.
 - h. Audible alarm, with silencing switch, to indicate when protection has failed.
 - i. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 - j. Four-digit, transient-event counter set to totalize transient surges.
- 2. Peak Single-Impulse Surge Current Rating: 160 kA per phase.
 - 3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.
 - a. Line to Neutral: 70,000 A.
 - b. Line to Ground: 70,000 A.
 - c. Neutral to Ground: 50,000 A.
 - 4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
 - 5. Protection modes and UL 1449 SVR for grounded wye circuits with 208Y/120 -V, three-phase, four-wire circuits shall be as follows:
 - a. Line to Neutral: 400 V for 208Y/120.
 - b. Line to Ground: 400 V for 208Y/120.
 - c. Neutral to Ground: 400 V for 208Y/120.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Alternate Maintenance Setting (AMS) Switch. Switch shall be provided for the temporary arc-flash incident energy reduction during maintenance activities. Provide for circuit breakers where the actual overcurrent device installed in the circuit breakers are rated or can be adjusted to 1,200 amps or higher.
 - a. Provide a manual switch on the compartment door to switch the circuit breaker's short-time tripping characteristics to instantaneous with

- minimum pick-up setting in order to reduce the danger from a potential arc-flash at downstream equipment.
 - b. Provide a lock feature for the AMS switch so that it may be locked in either the off or on maintenance mode position.
 - c. Provide a blue LED indicating light to indicate the AMS switch is in the maintenance mode.
- 2. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- 3. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- 4. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
- 5. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
- 6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- 7. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

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. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- C. Mount top of trim 72 inches above finished floor unless otherwise indicated.

- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- E. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- I. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "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 Division 26 Section "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 Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Perform each visual and mechanical inspections and electrical tests recommended by the manufacturer. 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.
- B. Panelboards will be considered defective if they do not pass tests and inspections.
- C. 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.
- D. The contractor shall provide performance testing for the ground-fault protection system of service equipment. The testing shall be conducted by a qualified person(s) using primary current injection when the equipment is first installed on site.
 - 1. The testing shall be in accordance with the instructions provided with equipment.
 - 2. Provide a written record of this testing and include a copy in the O&M manuals.

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 indicated.

- 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.

END OF SECTION 26 24 16

SECTION 26 27 26 – WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to the general requirements specification, Section 26 05 00.
- B. 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. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Wall-box motion sensors.
 - 4. Snap switches and wall-box dimmers.
 - 5. Solid-state fan speed controls.
 - 6. Wall-switch and exterior occupancy sensors.
 - 7. Cord and plug sets.
 - 8. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.
- B. Related Sections include the following:
 - 1. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

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. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- 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.

1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 3. Leviton Mfg. Company Inc. (Leviton).
 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Receptacles shall have nickel-plated brass strap and a one piece strap with integral ground.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 5351 (single), 5352 (duplex).
 - b. Hubbell; HBL5351 (single), CR5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5381 (single), 5352 (duplex).

2.3 GFCI RECEPTACLES

- A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, safe lock protection, and include indicator light that is lighted when device is tripped.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; GF20.
 - b. Pass & Seymour; 2084.

2.4 TAMPER-RESISTANT RECEPTACLES

- A. 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. Products: Subject to compliance with requirements products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; TR8300.
 - b. Hubbell; HBL8300SGA.
 - c. Leviton; 8300-SGG.
 - d. Pass & Seymour; TR63H.

2.5 WEATHER-RESISTANT RECEPTACLES

- A. Convenience Receptacles: 125 V, 20 A; Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, and UL 498.
1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

- a. Cooper; WRBR20
- b. Hubbell; BR20WR.
- c. Leviton; WBR20.
- d. Pass & Seymour; WR20TRW.

2.6 USB CHARGING CONVENIENCE RECEPTACLES

- A. Duplex straight blade receptacle with (2) USB charging ports.
 - 1. Commercial Grade.
- B. 125V, 20A, NEMA 5-20R configuration.
- C. USB charging ports: (1) USB Type A and (1) USB Type C.
 - 1. High power 5 Amp, 5 Volt USB output.
 - 2. Ports rated 10,000 cycles.
- D. Listing and Standards:
 - 1. NEMA WD 1 and NEMA WD 6.
 - 2. UL498, UL 1310
 - 3. Comply with battery charging specification USB BC1.2.
 - 4. Compatible with USB 1.1/2.0/3.0/3.1

2.7 PLUG LOAD CONTROL RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Receptacle shall be marked to indicate that it is part of plug load control in accordance with the current version of the National Electrical Code. Receptacles shall have nickel-plated brass strap and a one piece strap with integral ground.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Leviton; 5362-1P (duplex/half controlled); 5362-S2 (duplex fully controlled)
 - b. Pass & Seymour; 5362CH (duplex/half controlled); 5362CD (duplex fully controlled)
 - c. Cooper
 - d. Hubbell

2.8 TWIST-LOCKING RECEPTACLES

- A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; L520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass & Seymour; L520-R.

2.9 PENDANT CORD-CONNECTOR DEVICES

- A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.

1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
2. 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.

2.10 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.11 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).
- C. Pilot Light Switches, 20 A:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221PL for 120 V and 277 V.
 - b. Hubbell; HPL1221PL for 120 V and 277 V.
 - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
 - d. Pass & Seymour; PS20AC1-PLR for 120 V.
 2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."
- D. Key-Operated Switches, 120/277 V, 20 A:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 2221L.
 - b. Hubbell; HBL1221L.
 - c. Leviton; 1221-2L.
 - d. Pass & Seymour; PS20AC1-L.
 2. Description: Single pole, with factory-supplied key in lieu of switch handle.

- E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 1995.
 - b. Hubbell; HBL1557.
 - c. Leviton; 1257.
 - d. Pass & Seymour; 1251.
- F. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; 1995L.
 - b. Hubbell; HBL1557L.
 - c. Leviton; 1257L.
 - d. Pass & Seymour; 1251L.

2.12 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
- C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
 - 1. 600 W; dimmers shall require no derating when ganged with other devices.
- D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.13 FAN SPEED CONTROLS

- A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.
 - 1. Continuously adjustable rotary knob, 1.5 A.
 - 2. Three-speed adjustable rotary knob, 1.5 A.

2.14 OCCUPANCY SENSORS

- A. Ceiling/Wall Sensors:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Watt Stopper (The);
 - b. Sensor Switch.
 - c. Hubbell.

2.15 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Kitchens: Stainless steel.
 - 3. Material for Finished Spaces: Stainless Steel.
 - 4. Material for Unfinished Spaces: Stainless Steel.
 - 5. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, "While In Use" die-cast aluminum with lockable cover.

2.16 FINISHES

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
 - 1. Wiring Devices Connected to Normal Power System: 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. TVSS Devices: As selected by Architect.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
 - 1. Take steps to insure that devices and their boxes are protected. 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 the 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 just 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.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.

- c. Pigtailing existing conductors is permitted provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace all devices that have been in temporary use during construction or that show signs that they 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 in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by the 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.
- 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. 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.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED 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 not acceptable.
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. The 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.

END OF SECTION 26 27 26

SECTION 26 28 16 – ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to the general requirements specification, Section 26 05 00.
- B. 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. Shunt trip switches.
 - 4. Molded-case circuit breakers (MCCBs).
 - 5. Molded-case switches.
 - 6. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
- 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. Manufacturer's field service report.
- D. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 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.
- 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.

1.6 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 and not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 1. Notify Architect and Owner no fewer than seven days in advance of proposed interruption of electric service.
 2. Indicate method of providing temporary electric service.
 3. Do not proceed with interruption of electric service without Architect's and Owner's written permission.
 4. Comply with NFPA 70E.

1.7 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, provide products by one of the following:
 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 3. Siemens Energy & Automation, Inc.
 4. Square D; a brand of Schneider Electric.

- B. Type HD, Heavy Duty, Single Throw, 230 or 600V ac as indicated, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 5. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Alternate Maintenance Setting (AMS) Switch. Switch shall be provided for the temporary arc-flash incident energy reduction during maintenance activities. Provide for circuit breakers where the actual overcurrent device installed in the circuit breakers are rated or can be adjusted to 1,200 amps or higher.

1. Provide a manual switch on the compartment door to switch the circuit breaker's short-time tripping characteristics to instantaneous with minimum pick-up setting in order to reduce the danger from a potential arc-flash at downstream equipment.
 2. Provide a lock feature for the AMS switch so that it may be locked in either the off or on maintenance mode position.
 3. Provide a blue LED indicating light to indicate the AMS switch is in the maintenance mode.
- D. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- E. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- F. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
1. Instantaneous trip.
 2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I²t response.
- G. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- H. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- I. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

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. Kitchen or Wash-Down Areas: NEMA 250, Type 4X, stainless steel .
 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 3R.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids:
NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Label each enclosure with engraved metal or laminated-plastic nameplate.

END OF SECTION 26 28 16

SECTION 26 29 13 – ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to the general requirements specification, Section 26 05 00.
- B. 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. Reduced-voltage solid state.
 - 5. Multispeed.

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 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. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for 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.
- 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. information, instruments, features, and accessories.

1.5 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.

1.6 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.

1.7 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 and not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 1. Notify Architect and Owner no fewer than seven days in advance of proposed interruption of electrical systems.
 2. Indicate method of providing temporary utilities.
 3. Do not proceed with interruption of electrical systems without Architect's and Owner's written permission.
 4. Comply with NFPA 70E.

1.8 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 in Division 03.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

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. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

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. Surface mounting.
 4. Red pilot light.
- C. 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.
 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; melting alloy type.
 4. Surface mounting.
 5. Red pilot light.
- D. 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 10 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 melting alloy type.
- 4. Surface mounting.
- 5. Red pilot light.
- E. 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.
 - 3. Contactor Coils: Pressure-encapsulated type.
 - 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: Voltage as required by mechanical equipment; obtained from integral CPT, with primary and secondary fuses with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 50 VA.
 - 6. Melting Alloy Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 10 tripping characteristic.
 - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - 7. External overload reset push button.
- F. 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 clips or bolt pads to accommodate Class R fuses.
 - 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.

2.2 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
 1. Dry and Clean Indoor Locations: Type 1.
 2. Outdoor Locations: Type 3R.
 3. Other Wet or Damp Indoor Locations: Type 4.
 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.3 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: Standard-duty type.
 - a. Push Buttons: Recessed types; maintained as indicated.
 - b. Pilot Lights: LED types; colors as indicated.
 - c. Selector Switches: Rotary type.
- B. N.C. and N.O. auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. 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.

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 Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Floor-Mounted Controllers: Install enclosed controllers on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section "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. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in each fusible-switch enclosed controller.
- E. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."
- F. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- H. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved nameplate.
 3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. 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. Tests and Inspections:
1. Inspect controllers, wiring, components, connections, and equipment installation.
 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 Engineer 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. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- C. Prepare 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 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 cooldown 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 Engineer before increasing settings.

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.

END OF SECTION 26 29 13

SECTION 26 33 23 – CENTRALIZED EMERGENCY INVERTERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to General Requirement Specifications, Section 260500.
- B. This section includes items pertaining to the central inverter.

1.2 SCOPE

- A. This specification defines the electrical and mechanical characteristics and requirements for an uninterruptible stored emergency power supply system.
- B. The system shall deliver reliable, high quality uninterruptible power for emergency illumination and related life safety equipment.
- C. Seismic
 - 1. Refer to the structural drawings and specifications for seismic design requirements.
 - 2. Refer to the Seismic and Wind Controls for Electrical Systems specification, section 26 05 48 for additional requirements.
 - 3. The specified work in this section must withstand the seismic hazard design loads for the installed elevation above and below grade.
 - a. The term 'withstand' means 'unit must remain in place without separation of parts from unit when subjected to specified seismic design and unit must be fully operational after seismic event'.

1.3 SUBMITTALS

- A. Product Data:
 - 1. Provide manufacturer's product data sheets for each component to be utilized on this project. Provide technical data on features, performance, electrical characteristics, ratings, accessories and finishes.
- B. Shop Drawings:
 - 1. Include dimensioned plan and elevation views of inverters. Indicate dimensions, weights and required clearances.
 - 2. Indicate voltage, bus ampacities, overcurrent protective device arrangement and sizes, short-circuit current ratings, and conduit entry locations.
- C. Seismic Performance Certificates
 - 1. Provide certificates for the equipment and accessories, from the manufacturer. Include the following:
 - a. Basis for Certification
 - i) Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outlined Drawings of Equipment
 - i) Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

1.4 OPERATION AND MAINTENANCE MANUALS

- A. Provide detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
 - 1. Include manufacturer, supplier, support, and repair center contact information.
 - 2. Include manufacturer's standard operation and maintenance data assembled for each size and type of equipment furnished.
 - 3. Include contact information for parts stocking location closest to Owner.
 - 4. Identify critical spare parts associated with long lead times and/or those critical to unit operation.
 - 5. Identify maintenance spare parts required to regularly perform scheduled equipment maintenance including, but not limited to, consumable parts required to be exchanged during scheduled maintenance periods.
- B. Provide a copy of the functional testing report(s).
- C. Provide a copy of the owner training sign-in sheet.
- D. Provide a digital copy of the recording from the owner training session.
- E. Provide a copy of the manufacturer's warranty.

1.5 QUALITY ASSURANCE

- A. Listed UL Standards - UL 924 Emergency Lighting Equipment with 90 minutes, (or UL 924 Auxiliary Lighting and Power Equipment for other than 90 minutes battery backup time), UL 1778 UPS Equipment.
- B. The manufacturer shall be a United States based manufacturer with 10 years experience or greater in design and fabrication of centralized stored electrical energy emergency and standby power systems.

1.6 WARRANTY

- A. The manufacturer shall guarantee all power components and system electronics to be free from defects in material and workmanship for a period of 2 years from the date of substantial completion.
- B. Battery warranty shall be 1-year full replacement, 14 years pro-rated, starting from the date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Isolite
 - 2. Trystar
 - 3. Dual-Lite

2.2 MANUFACTURED UNITS

- A. The system shall be designed and manufactured to assure maximum reliability, serviceability and performance.
- B. The system shall include one main control module for rapid service or replacement. The local display shall be mounted on the front of the system for easy observation of system status and battery condition.

- C. The battery and DC conductors shall be DC fuse protected. All conductors and transformer windings shall be copper constructed.
- D. Cabinets are floor mountable, constructed of steel, front accessible through a hinged, key lockable door and shall be NEMA 1 rated for indoor use.
- E. Operation:
 - 1. Systems shall operate in accordance with requirements as specified herein to support any the loads indicated on the drawings, up to the rating of the system. "Normally on" AC output bus shall be 100% rated and limited only by the system maximum KW output rating.
 - 2. Normal Operation: The load shall be supplied with regulated power derived from the normal AC power input terminals through the rectifier charger and inverter. The rectifier charger shall be fully rated to charge the batteries and supply sufficient DC energy for the inverter when under full load. The battery shall be connected in parallel with the rectifier charger output.
 - 3. Uninterrupted Emergency Operation: Upon the failure or unacceptable deviation of commercial AC power, energy shall be supplied by the battery through the inverter and continue to supply power to the load without switching loss or disturbance. When power is restored at the AC input terminals of the system, the rectifier charger shall continue to supply power to the load through the inverter and simultaneously recharge the batteries. There shall be no break or interruption of power to the load upon failure or restoration of the commercial AC power.
 - 4. Automatic Bypass Operation: The system shall include an automatic bypass switch for fault clearing, instantaneous overload conditions and/or to connect the load to the normal utility source in the event of a system rectifier charger or inverter failure.
 - 5. Secure Bypass Switch: The system shall include an integral, secure, make-before-break bypass switch accessible via the front of the inverter enclosure through a hinged, key lockable door. The secure bypass switch shall incorporate a push-to-turn function. Pushing the bypass switch shall invoke the inverter's static bypass and indicate that it is safe to turn the switch to the bypass mode. The secure bypass switch shall provide complete isolation of the inverter output terminals from external circuits. When the load is supplied from the utility through the secure bypass switch, the AC supply terminals shall remain energized to permit operational checking of the inverter, but the inverter output shall remain isolated from the load.

2.3 INPUT SPECIFICATIONS

- A. Input Voltage: See drawings.
- B. Input Voltage Operating Range: +12% to -15% at full load without battery usage.
- C. Extended Range: The unit shall incorporate the use of variable range logic in conjunction with the load percentage to extend the input range up to +12% to -30% without battery usage while maintaining a regulated, usable output voltage.
- D. Frequency Range: 57.5 Hz to 62.5 Hz.
- E. Power Factor: Self-correcting to >0.97 (approaching unity).
- F. Input Current Harmonics: <5% THD (total harmonic distortion).
- G. System AIC (Amperes Interrupting Current) Rating: See drawings.

2.4 OUTPUT SPECIFICATIONS

- A. Output Voltage: See drawings.
- B. Sine Wave Voltage: Maximum 3% harmonic distortion under linear load.
- C. Frequency: 60 hertz + 0.5% under full load while in the battery operation mode.
- D. Harmonic Attenuation: Reflected load generated harmonics shall be attenuated at the input.
- E. Voltage Regulation: +/-2%.
- F. Output Power Rating: See drawings

2.5 BATTERY SPECIFICATIONS

- A. Battery time: 90 Minutes at full rated kilowatt output capability, UL 924 Listed as Emergency Lighting Equipment. 90 minutes at full rated kilowatt capability, UL 924 Listed as Auxiliary Lighting and Power Equipment.
- B. Battery Type: Integral, valve regulated, sealed lead calcium, maintenance free.
- C. Charger: 4 stage, temperature compensated, 1% ripple filtered.
- D. Recharge Time: 24hrs, UL 924, NFPA 101 complaint.

2.6 PERFORMANCE SPECIFICATIONS

- A. Overload Rating (without use of static bypass): Up 125% for 30 cycles, 150% for 4 cycles when fed from the AC power source, or on battery.
- B. LED Inrush Rating (without use of static bypass): Peak overload capability to accommodate inrush current from LED fixtures/drivers.
- C. Fault Clearing (with bypass available): 125% for 2 minutes, 150% for 30 seconds and 200% for 15 cycles when fed from AC power source.
- D. Voltage Regulation: The output voltage shall be regulated to within +2% during input voltage changes from +12% to – 15% with reference to nominal, and when the output is loaded from no load to full rated load.
- E. Common Mode (isolation transformer units only): 120 dB (106 : 1 ground noise attenuation).
- F. Transverse Mode (isolation transformer units only): 70 dB (3160 : 1 line noise attenuation).
- G. Reactive Power Correction: Load at .6 pf corrected to > 0.97 at input (automatically correcting).
- H. Reliability: 100,000 hours MTBF.

2.7 ENVIRONMENTAL SPECIFICATIONS

- A. Operating Temperature: UL 924 listed Emergency Lighting Equipment at 20°C (68°F) to 30°C (86°F).
- B. C-UL listed to CSA C22.2 No. 141-15 with 30 minutes at 20°C (68°F) to 30°C (86°F).
- C. UL 924 Auxiliary Lighting and Power Equipment, UL 1778, and C-UL listed to CSA C22.2 No.107.1-01 at 0°C (32°F) to 40°C (104°F).
- D. Storage Temperature: -20°C to 50°C
- E. Relative Humidity: 95% non-condensing.
- F. Elevation: 5000 feet, 1500 meters without de-rating.
- G. Audible Noise Level: Not greater than 50 dba at 1 meter.

2.8 DISPLAY MONITOR AND DIAGNOSTICS

- A. Display Panel – Systems shall include a local, front mounted, LED display panel to indicate system status and battery condition. Display shall include provisions to automatically monitor inverter input voltage normal, inverter input voltage high, inverter input voltage low, inverter on bypass, % load, battery in use, battery full, battery low and check battery.
- B. Audible Alarm – The display panel shall include an audible alarm with alarm silence for system on battery, low battery, check battery, over temperature warning, system fault, inverter overloaded.
- C. Control Functions – Push button for inverter on, fail safe dual push buttons for inverter off, alarm silence push button and push button for system battery testing.
- D. Communications Port (RS232) – Include communications port for remote monitoring access to electrical measurements, system set point programming and system log.
- E. Electrical Measurements (RS232) – Electrical measurements shall include: Input voltage L1-neutral, Input voltage L2- neutral, Input voltage L1-L2, output voltage L1-neutral, output voltage L2-neutral, output voltage L1-L2, output current (amps) L1-neutral, output current (amps) L2-neutral, output watts L1- neutral, output watts L2-neutral, output watts L1-L2, output volt amperes L1-neutral, output volt amperes L2-neutral, output volt amperes L1-L2, % load L1-neutral, % load L2-neutral, battery voltage and DC charging current, output frequency. Note that “L2” parameters shall be measured when applicable.
- F. System Set Points (RS232) – Include provision to program the following: The percentage point at which the display panel indicates the low battery alarm, sag point at which battery usage is to occur, surge point at which battery usage is to occur, and points at which automatic battery tests are to be performed (7 day intervals, 30 day intervals, or 90 day intervals).
- G. System Log (RS232) – System shall include provision to log power outages with date and time and system overloads with date and time.
- H. Automatic Self-Testing – System shall provide a 5-minute automatic battery test programmable for every 7, 30, or 90 days in compliance with NFPA 101.
- I. Manual Battery Testing – System shall provide a push to test feature in the event that a manual battery test is required.

2.9 RELAY COMMUNICATIONS INTERFACE

- A. Status / Alarm relay interface normally open contacts shall be provided for optional remote annunciator panel or automatic message dialer. Include potential free, 120vac @ 0.5amps, contacts for inverter on battery, low battery warning, and general alarm.
- B. A normally closed Battery Test Active contact shall be provided that opens during automatic or manual system testing.

2.10 ACCESSORIES

- A. Provide automatic utility power bypass switch.
- B. Include network device (BACnet/IP) adapter for network communication of inverter system status and electrical measurement data.

2.11 SERVICEABILITY

- A. Each inverter system contains one front-accessible electronics module subassembly. Batteries shall be positioned and wired to facilitate rapid replacement.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Receive, inspect, handle, and store central battery equipment according to NECA 411.
- B. Examine areas, surfaces, and substrates to receive central battery equipment, with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

3.2 INSTALLATION

- A. Coordinate layout and installation of central battery equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install central battery equipment and accessories according to NECA 411.
- C. Floor-Mounted Central Battery Equipment: Install central battery equipment on a 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
 - 1. 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.
 - 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.
- D. Comply with NECA 1.
- E. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.
- F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- G. Install wiring between central battery equipment and remote devices and the Building Automation System.
- H. Bundle, train, and support wiring in enclosures.
- I. Identify central battery equipment, components, and control wiring. Refer to the Electrical Equipment Identification Detail on the drawings for additional information.
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label central battery equipment with engraved nameplates.
 - 3. Label each separate cabinet, for multicabinet units.
 - 4. Label each enclosure-mounted control and pilot device.
- J. Operating Instructions: Frame printed operating instructions for central battery equipment, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of central battery equipment units.

- K. Start-Up
 - 1. Engage a factory-authorized service representative to perform startup service.
 - 2. Complete installation and startup checks according to manufacturer's written instructions.
- L. Adjusting
 - 1. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
 - 2. Set field-adjustable switches, auxiliary relays, and other adjustable parts.
 - 3. Adjust the trip settings of thermal-magnetic circuit breakers with adjustable, instantaneous-trip elements; install fuses if not factory installed.
 - 4. Set the automatic system test parameters.

3.3 FUNCTIONAL TESTING

- A. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
 - 1. Inspect central battery equipment, wiring, components, connections, and equipment installation. Test and adjust components and equipment per manufacturer's instructions.
 - 2. Verify that input voltages and frequencies at central battery equipment locations are within voltage and frequency limits specified in Part 2.
 - 3. Perform a load-duration test at rated voltage and rated output current to verify the correct functional operation of the unit under full-load stable operating conditions for the minimum time limits required by UL 924. Monitor and record ambient temperature and temperatures within the unit.
 - 4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Prepare test and inspection reports, including a certified report that identifies central battery equipment and describes all test results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.
 - 1. Include a copy in the Operation and Maintenance Manual.

3.4 OWNER TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central battery equipment, and to use and reprogram microprocessor-based control, monitoring, and display functions.
 - 1. Include a minimum of four (4) hours of training.

END OF SECTION 26 33 23

SECTION 26 51 00 – LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to the General Requirements Specifications, Section 260500.
- B. Section Includes:
 - 1. Interior and exterior lighting fixtures, LED drivers.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.
 - 5. Poles and accessories.

1.2 SCOPE

- A. Provide lighting as described on the Contract Drawings and in the specifications.
- B. Refer to the light fixture schedule on the Contract Drawings for specific light fixture requirements and acceptable manufacturers.
- C. Basis of Design light fixtures are described and listed on the fixture schedule with corresponding catalog numbers. Equivalent manufacturers listed in the schedule without corresponding catalog numbers are responsible for meeting the quality standards and photometric distribution set by the specified product.
 - 1. Identification of the basis of design light fixtures by means of manufacturers' names and catalog numbers is to establish basic features, quality and performance standards, and it is not intended to limit competition. Any substitutions must meet or exceed these standards.
- D. Substitutions and/or requests to have a manufacturer added as an acceptable equivalent manufacturer shall be made no later than 14 days prior to the bid date.
- E. Those proposing substitutions shall submit the following to the engineer:
 - 1. Product Data Sheets for each fixture. Product Data Sheets shall include at a minimum a picture and description of fixture construction, lamp type, efficiency, and any accessories.
 - 2. The engineer may require lighting calculations for specific areas to ensure the substitute fixtures will provide adequate lighting levels.
- F. Seismic
 - 1. Refer to the structural drawings and specifications for seismic design requirements.
 - 2. Refer to the Seismic and Wind Controls for Electrical Systems specification, section 26 05 48 for additional requirements.
 - 3. The specified work in this section must withstand the seismic hazard design loads for the installed elevation above and below grade.
 - a. The term 'withstand' means 'unit must remain in place without separation of parts from unit when subjected to specified seismic design and unit must be fully operational after seismic event'.

1.3 SUBMITTALS

- A. Product Data:

1. For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - a. Physical description of lighting fixture and poles including dimensions, materials, and finishes.
 - b. Emergency lighting units including battery and charger.
 - c. LED drivers.
 - d. Life (L70 for LED), output (lumens, CCT, and CRI), and energy-efficiency data.
 - e. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - f. Details of attaching luminaires and accessories.
 - g. Anchor bolts for poles.
 - h. Manufactured pole foundations.
- B. Seismic Performance Certificates
 1. Provide certificates for the equipment and accessories, from the manufacturer. Include the following:
 - a. Basis for Certification
 - 1) Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outlined Drawings of Equipment
 - 1) Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
- 1.4 OPERATION AND MAINTENANCE MANUALS
 - A. Provide a list of all warranties, per fixture type, that extend beyond one year from the date of substantial completion.
- 1.5 WARRANTY
 - A. Special Warranty for Emergency Lighting Batteries: The manufacturer agrees to replace or repair components that fail in material or workmanship within the specified period.
 1. Warranty Period for Emergency Lighting Unit Batteries: Three years from the date of Substantial Completion.
 2. Warranty Period for Self-Powered Exit Sign Batteries: Three years from the date of Substantial Completion.
 3. The Contractor shall be responsible for replacing or repairing all components that fail within one year of the date of Substantial Completion.
 4. Warranties that extend beyond one year after Substantial Completion shall apply to materials only. Labor is excluded after the first year.

- B. Special warranty for LED luminaires and devices: The manufacturer agrees to repair or replace the driver and all components of the luminaire that fail in materials or workmanship or have a loss in performance within the specified warranty period listed below:
 - 1. Warranty Period: Five (5) years from the date of substantial completion.
 - 2. The Contractor shall be responsible for repairing or replacing all components that fail within one year of the date of substantial completion.
 - 3. Warranties that extend beyond one year from the date of substantial completion shall apply to material only. Labor is excluded after the first year.
- C. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
 - 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
 - 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
 - 4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.
 - 5. The Contractor shall be responsible for repairing or replacing all components that fail within one year of the date of substantial completion.
 - 6. Warranties that extend beyond one year from the date of substantial completion shall apply to material only. Labor is excluded after the first year.

PART 2 - PRODUCTS

2.1 LUMINAIRES

- A. Refer to the light fixture schedule on the drawings.

2.2 GENERAL REQUIREMENTS

- A. Exterior luminaires shall be U. L. listed and labeled for installation in wet locations. Interior luminaires located in wet environments shall be U. L. listed and labeled for installation in wet locations.
- B. Luminaire colors to be selected by Architect during shop drawing review.
- C. Provide a safety cable for all high-bay light fixtures.
- D. Poles and Support Components:
 - 1. Structural Characteristics: Comply with AASHTO LTS-6-M.
 - a. The manufacturer shall be responsible for selecting poles, and other luminaire-supporting components and certifying them to suit wind, ice, and other load conditions.
 - 2. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

3. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 - a. Materials: Shall not cause galvanic action at contact points.
 - b. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
 - c. Anchor-Bolt Template: Plywood or steel.
4. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.
5. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Refer to the pole base details(s) on the Contract Drawings.
 - a. Any construction deviations to the pole base detail shown on the contract drawings must be designed by a registered structural engineer and approved by the electrical engineer. It is the contractor's responsibility to procure a structural engineer's services.
6. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, listed for attaching grounding and bonding conductors of type and size indicated on drawings, and accessible through handhole.

2.3 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports, and nonmetallic channel and angle supports.
- B. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- C. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- D. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Store and support poles to prevent distortion and arrange to provide free air circulation.

3.2 INSTALLATION

- A. Comply with the manufacturer's installation recommendations and guidelines.
- B. Set lighting fixtures level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Remote Mounted LED Drivers:
 1. Distance between the driver and fixture shall not exceed that recommended by driver manufacturer. Verify, with driver manufacturers, maximum distance between driver and luminaire.
 2. Install driver in accessible location.
- D. Lay-in Ceiling Lighting Fixtures Supports:
 1. Use grid as support element.
 2. Fasten support clips to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 3. Install fixtures of sizes less than ceiling grid as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

4. Install at least two independent support rods or wires from the structure to tabs at diagonal corners of each lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- E. Suspended Lighting Fixture Support:
1. Brace pendants and rods longer than 48 inches to limit swinging.
 2. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
 3. Provide an independent safety cable for fixtures located in gymnasiums, cafeterias, or other areas where fixtures are subject to damage. The safety cable shall be installed from the fixture to the structure.
- F. Pole Installation
1. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
 2. Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
 - a. Fire Hydrants and Storm Drainage Piping: 60 inches.
 - b. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet .
 - c. Trees: Outside of drip line..
 3. Set anchor bolts in concrete pole bases according to anchor-bolt templates furnished by pole manufacturer.
 - a. Finish concrete base by troweling and rubbing smooth.
- G. Bollard Luminaire Installation
1. Align units for optimum directional alignment of light distribution..
 2. Install on concrete base at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth.
- H. Installation Of Individual Ground-Mounting Luminaires.
1. Install on concrete base at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth.
- I. Corrosion Prevention
1. Do not use aluminum in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- J. Grounding
1. Ground metal poles and support structures:
 - a. Install grounding electrode for each pole unless otherwise indicated.
 - b. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
 2. Ground nonmetallic poles and support structures:
 - a. Install grounding electrode for each pole.
 - b. Install grounding conductor and conductor protector.
 - c. Ground metallic components of pole accessories and foundations.

3.3 FUNCTIONAL TESTING

- A. Interrupt power supply to emergency lighting to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
- C. Verify luminaires are operating seamlessly with the lighting controls.

END OF SECTION 26 51 00

SECTION 26 56 68 – EXTERIOR ATHLETIC LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to the General Requirements specifications, Section 260500.
- B. This section includes items pertaining to the exterior athletic lighting, including but not limited to the following:
 - 1. Poles, Crossarms, and other accessories
 - 2. Pole Foundations
 - 3. Lighting Controls
 - 4. Light Fixtures

1.2 SCOPE

- A. Provide an athletic lighting system complying with the Kentucky High School Athletic Association's (KHSAA) requirements.
 - 1. Provide a lighting system for the following venues:
 - a. Football
 - b. Baseball
 - c. Softball
 - d. Soccer
 - e. Softball
 - f. Track & Field
- B. Provide a complete and operational system as described within this specification and as shown on the drawings.
- C. All miscellaneous items and accessories required for a complete and operational system shall be provided whether or not each item is explicitly mentioned in these specifications or shown on the contract drawings.
 - 1. The contractor is responsible for providing all line voltage circuits necessary for the operation of the system.
- D. Seismic
 - 1. Refer to the structural drawings and specifications for seismic design requirements.
 - 2. Refer to the Seismic and Wind Controls for Electrical Systems specification, section 26 05 48 for additional requirements.
 - 3. The specified work in this section must withstand the seismic hazard design loads for the installed elevation above and below grade.
 - a. The term 'withstand' means 'unit must remain in place without separation of parts from unit when subjected to specified seismic design.

1.3 SUBMITTALS

- A. Product Data
 - 1. Provide the manufacturer's product data sheets for each component to be utilized on this project.

B. Shop Drawings

1. Site drawing(s) showing field layouts with pole locations.
2. Lighting design and calculation drawing(s) indicating the following:
 - a. Outline of the field(s) being lighted with pole locations referenced to the center of the field (x, y coordinates).
 - b. Pole height, luminaire mounting heights, number of fixtures per pole, horizontal and vertical aiming angles.
 - c. Luminaire wattage, lumens, optics, and other information.
 - 1) Total wattage per circuit and/or pole.
 - d. At specified grid spacing, provide the following field lighting calculations:
 - 1) Average, minimum, and maximum illuminance levels in footcandles.
 - 2) Uniformity
 - 3) Coefficient of Variance
 - 4) Coefficient of Utilization uniformity gradient
 - e. Spill Lighting and Glare Control calculations:
 - 1) Indicate lighting levels along and beyond the property boundary.
 - f. Lighting control schematics.
3. Structural Design indicating the following:
 - a. Stamp and signature of the structural engineer performing the design.
 - b. Structural calculations.
 - c. Foundation design

C. Seismic Performance Certificates

1. Provide certificates for the equipment and accessories, from the manufacturer. Include the following:
 - a. Basis for Certification
 - 1) Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outlined Drawings of Equipment
 - 1) Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

1.4 OPERATION AND MAINTENANCE MANUALS

- A. Provide a copy of the functional test results and certifications.
- B. Provide contact information. The contact information shall include names, physical addresses, phone numbers and email addresses of the following:
 1. Installing company.
 2. Specific contact person(s) for technical assistance, service and maintenance.

3. Emergency contact information for after-hours technical assistance, service and maintenance.
 - C. Provide a copy of the owner training sign-in sheet.
 - D. Provide a digital copy of the recording from the owner training session.
 - E. Provide a copy of the manufacturer's warranty.
 - F. Provide an operation/user manual detailing operating instructions, programming instructions, maintenance requirements and trouble-shooting procedures.
- 1.5 QUALITY ASSURANCE
- A. All components shall be designed and manufactured as a system. All luminaires, wire harnesses, drivers and other enclosures shall be factory assembled, aimed, wired and tested.
- 1.6 WARRANTY
- A. Provide a signed manufacturer's warranty covering the entire system for 25 years from the date of substantial completion.
 1. The warranty shall guarantee the specified light levels for the duration of the warranty period.
 - B. The manufacturer shall monitor the performance of the lighting system, including on/off status, hours of usage and luminaire outage for 25 years from the date of substantial completion.
 1. All communication and monitoring costs for the 25-year period shall be included in the bid/cost.
 2. Individual luminaire outages will be repaired when the usage of any field is materially impacted. The manufacturer is responsible for removal and replacement of failed luminaires, including all parts, labor, shipping, and equipment rental associated with maintenance.
 3. The Owner agrees to check fuses in the event of a luminaire outage.

PART 2 – PRODUCT

2.1 ACCEPTABLE MANUFACTURERS

- A. The owner's preferred vendor shall be carried in the base bid. The owner's preferred vendor is as follows:
 1. MUSCO Light-Structure System™ (Basis-of-Design)
- B. Submit alternate price for equal sports lighting from one of the manufacturers listed below. The equal products shall meet all requirements herein – or any exception shall be clarified in the bid.
 1. Truly Green Solutions
 2. Acuity – M3

2.2 PERFORMANCE REQUIREMENTS

- A. Performance shall meet 2021 KHSAA Lighting Standards
- B. Lighting Levels
 1. Lighting levels shall be measured 36 inches above the field surface.
 2. Football Field
 - a. Light Level: 30 footcandles average.

- b. Light Level Grid Spacing: 30' x 30'
 - c. Max to Min Ratio: 2.5:1 or less.
 - d. Pole Height: 80'-90'
- 3. Soccer Field
 - a. Light Level: 30 footcandles average.
 - b. Light Level Grid Spacing: 30' x 30'
 - c. Max to Min Ratio: 2.5:1 or less.
 - d. Pole Height: 70'
- 4. Baseball Field
 - a. Light Level: Infield – 50 footcandles average, Outfield – 30 footcandles average.
 - b. Light Level Grid Spacing: 30' x 30'
 - c. Max to Min Ratio: 2.5:1 or less.
 - d. Pole Height: 70'
- 5. Softball Field
 - a. Light Level: Infield – 50 footcandles average, Outfield – 30 footcandles average.
 - b. Light Level Grid Spacing: 20' x 20'
 - c. Max to Min Ratio: 2.5:1 or less.
 - d. Pole Height: 60'-70'
- 6. Track & Field
 - a. Light Level: Infield – 50 footcandles average, Outfield – 30 footcandles average.
 - b. Light Level Grid Spacing: 20' x 20'
 - c. Max to Min Ratio: 2.5:1 or less.
 - d. Pole Height: See Football Field

- C. The lighting design and luminaire selection shall be optimized for playability by reducing glare onfield and providing sufficient uplight.
 - 1. To reduce glare, luminaire aiming shall ensure the top of the luminaire field angle (based on sample photometric reports) is a minimum of 10 degrees below horizontal.
 - 2. Luminaires shall have glare control technology including, but not limited to: external visors, internal shields and louvers.
 - 3. Adequate illumination shall be provided above the field in order to see the ball in flight. A lighting analysis shall be performed above the field of play to evaluate the visibility of the ball over its typical trajectory to ensure the participants will adequately see the ball. Calculation planes shall be evaluated up to the maximum anticipated height for the level of play.
 - 4. To ensure proper aiming angles, minimum mountings heights shall be as described on the drawings.

D. Spill Light and Glare Control

1. To minimize impact on adjacent properties, spill light and candela values must not exceed the following levels taken at a maximum 30' intervals and 5 feet above grade:
 - a. 150ft from the edge of any field or track due to the lighting of that field or track:
 - 1) Horizontal Footcandles: .05 average; .20 max
 - 2) Vertical Footcandles: .09 average; .35 max

2.3 SPORTS LIGHTING SYSTEM CONSTRUCTION

A. Lighting system shall consist of the following:

1. LED luminaries.
 - a. 5700K minimum color temperature.
 - b. 75 CRI
2. Galvanized steel poles and cross-arm assembly.
3. Lighting systems shall use concrete foundations.
4. Manufacturer will supply all drivers and supporting electrical equipment.
 - a. Remote drivers and supporting electrical equipment shall be mounted approximately 10 feet above grade in aluminum enclosures.
 - 1) The enclosures shall be touch-safe and include drivers and fusing with indicator lights on fuses to notify when a fuse is to be replaced for each luminaire. Disconnect per circuit for each pole structure shall be located in the enclosure.
 - b. Manufacturer shall provide surge protection at the pole equal to or greater than 40 kA for each line to ground (Common Mode) as recommended by IEEE C62.41.2_2002.
 - c. Wire harness complete with an abrasion protection sleeve, strain relief and plug-in connections for fast, trouble-free installation.
5. Control cabinet to provide remote on-off control, monitoring, and entertainment features of the lighting system.
6. Manufacturer shall provide lightning grounding as defined by NFPA 780 and be UL Listed per UL 96 and UL 96A.
7. Integrated grounding via concrete encased electrode grounding system.

B. All exposed components shall be constructed of corrosion resistant material and/or coated to help prevent corrosion.

1. All exposed carbon steel shall be hot dip galvanized per ASTM A123.
2. All exposed aluminum shall be powder coated with high performance polyester or anodized.
3. All exterior reflective inserts shall be anodized, coated, and protected from direct environmental exposure to prevent reflective degradation or corrosion.
4. All exposed hardware and fasteners shall be stainless steel, passivated and coated with aluminum-based thermosetting epoxy resin for protection against corrosion and stress corrosion cracking.

5. Structural fasteners may be carbon steel and galvanized meeting ASTM A153 and ISO/EN 1461 (for hot dipped galvanizing), or ASTM B695 (for mechanical galvanizing).
6. All wiring shall be enclosed within the cross-arms, pole, or electrical components enclosure.

2.4 ELECTRICAL

- A. Refer to the drawings for electrical requirements.

2.5 CONTROL

- A. System shall provide for instant on/off of luminaires.
- B. Lighting contactor cabinet(s) shall be constructed of NEMA Type 4 aluminum, designed for easy installation with contactors, labeled to match field diagrams and electrical design. Manual off-on-auto selector switches shall be provided.
- C. To minimize wear on drivers and other electrical components and prevent lights from turning on due to communication loss, circuits must be controlled via contactor switching.
- D. System shall provide for 3-stage dimming (high-medium-low). Dimming will be set via scheduling options (Website, app, phone, fax, email).
- E. System shall allow owner and users with a security code to schedule on/off system operation via a web site, phone, fax or email up to ten years in advance. Manufacturer shall provide and maintain a two-way TCP/IP communication link. Trained staff shall be available 24/7 to provide scheduling support and assist with reporting needs.
 1. The owner may assign various security levels to schedulers by function and/or fields. This function must be flexible to allow a range of privileges such as full scheduling capabilities for all fields to only having permission to execute "early off" commands by phone. Scheduling tool shall be capable of setting curfew limits.
 2. Controller shall accept and store 7-day schedules, be protected against memory loss during power outages, and shall reboot once power is regained and execute any commands that would have occurred during outage.
- F. System shall monitor lighting performance and notify manufacturer if individual luminaire outage is detected so that appropriate maintenance can be scheduled. The controller shall determine switch position (manual or auto) and contactor status (open or closed).
- G. Manufacturer shall provide a web-based database and dashboard tool of actual field usage and provide reports by facility and user group. Dashboard shall also show current status of luminaire outages, control operation and service. Mobile applications shall be provided and suitable for IOS, Android and Blackberry devices.
- H. Manufacturer shall provide a means of tracking actual hours of usage for the field lighting system that is readily accessible to the owner.
 1. Cumulative hours shall be tracked to show the total hours used by the facility.
 2. Report hours saved by using early off and push buttons by users.
- I. Control system shall interface with drivers in electrical components enclosures by means of powerline communication.

2.6 STRUCTURAL PARAMETERS

- A. The structural design of the foundation is delegated to the contractor.
 1. The design shall be prepared by a structural engineer licensed in the state where the project is located.

2. The design shall use the applicable building codes adopted by the governing agencies where the project is located.
 3. The foundation design shall be based on soil parameters as outlined in the geotechnical report.
- B. The stress analysis and safety factor of the poles shall conform to AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

PART 3 – EXECUTION

3.1 COORDINATION

- A. Coordinate programmed lighting scenes with Owner's representative.

3.2 INSTALLATION

- A. Light fixtures shall be field measured and installed by the manufacturer.
- B. Install the system as described within this specification, and indicated on the drawings, and according to the manufacturer's instructions.
- C. Refer to specification section 260533 Raceways, Boxes, Power Conductors and Cables for conduit and wiring installation requirements.
- D. Adjust luminaires and supports to maintain orientation and aiming as indicated and necessary to meet the lighting performance requirements.
- E. Install all components level, plumb, and square.
- F. All raceways and wiring shall be concealed below grade and within poles.
1. Exposed raceway is not permitted.
- G. Provide all system programming for scene control, on/off control, remote operation, etc.

3.3 FUNCTIONAL TESTING

- A. Light meters shall be calibrated within the last 12 months.
- B. Upon substantial completion of the project and in the presence of the Contractor, Project Engineer, Owner's Representative, and Manufacturer's Representative, illumination measurements shall be taken and verified. The illumination measurements shall be conducted in accordance with IESNA LM-5-04.
- C. Field measurements shall be taken on the grid spacing indicated in this specification for the respective field.
1. The field shall be divided into grids with the light measurement taken in the center of each grid.
 2. The light meter shall be held horizontally 36" above grade.
 3. Verify and document the Maximum Reading (fc), Minimum Reading (fc), Average Reading (fc), and Uniformity Ratio.
- D. Spill Lighting Verification
1. Lighting measurements shall be taken at 30' maximum intervals.
 2. The light sensing surface of the light meter should be held 36 inches above grade with the sensing surface horizontal (for horizontal readings) or vertically pointed at the brightest light bank (for max vertical readings).
 3. Verify and document the Maximum Reading and Average Reading (fc, candela).

- E. A manufacturer's representative shall provide start-up and commissioning of the lighting system in accordance with the manufacturer's instructions. The representative shall provide the following at a minimum:
 - 1. Verification of control operations.
 - 2. Verification programming is complete.
 - 3. Verification wiring and installation is complete.
 - 4. Account set-up with manufacturer.
 - 5. Document testing.
- F. Lighting systems not meeting the requirements described in the contract documents will be considered defective.
 - 1. The contractor shall correct any deficiencies and retest as necessary to bring the system into compliance with the contract documents.

3.4 OWNER TRAINING

- A. Owner training shall not occur until the system is fully operational, software programmed, and all punch list items are completed. If 3rd party commissioning is provided for the project, the owner training shall not occur until the resolution tracking form is completed.
- B. The presenter/trainer shall be a manufacturer's authorized representative familiar with the system(s).
- C. The contractor shall provide the following at a minimum for owner training:
 - 1. Sign-in sheet documenting the attendees and presenter's names and contact information.
 - a. Include the date and time the training occurred.
 - 2. A copy of the operation manual for the system shall be provided to each attendee.
 - a. The operation manual shall be reviewed with the attendees in conjunction with the physical demonstration of the system.
 - 3. Eight (8) hours total of in-service training.
 - a. The training time shall be divided into a minimum of two segments occurring on separate days.
 - 4. The training shall be digitally recorded (audio and video). A copy of the recording shall be included with the O&M manual.

END OF SECTION 26 56 68

SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to the general requirements specification, Section 26 05 00.
- B. Section Includes:
 - 1. Telecommunications mounting elements.
 - 2. Backboards.
 - 3. Telecommunications equipment racks and cabinets.
 - 4. Telecommunications service entrance pathways.
 - 5. Grounding.
 - 6. Power strips.

1.2 SCOPE

- A. Provide equipment for, and construct, the communications equipment room(s) as indicated on the contract drawings and described within the specifications. Communications equipment rooms may also be referred to as the following:
 - 1. MDF – Main Distribution Frame
 - 2. IDF – Intermediate Distribution Frame
- B. Seismic
 - 1. Refer to the structural drawings and specifications for seismic design requirements.
 - 2. Refer to the Seismic and Wind Controls for Electrical Systems specification, section 26 05 48 for additional requirements.
 - 3. The specified work in this section must withstand the seismic hazard design loads for the installed elevation above and below grade.
 - a. The term 'withstand' means 'unit must remain in place without separation of parts from unit when subjected to specified seismic design and unit must be fully operational after seismic event.

1.3 SUBMITTALS

- A. Product Data
 - 1. Provide the manufacturer's product data for each component to be utilized on this project.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 - b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Qualification Data
 - 1. Provide copy of certifications for Installer and installation supervisor.
- C. Seismic Performance Certificates
 - 1. Provide certificates for equipment and accessories from the manufacturer. Include the following:

- a. Basis for Certification
 - 1) Indicate whether withstand certification is based on actual test of assembled components or on calculation.
- b. Dimensioned Outlined Drawings of Equipment
 - 1) Identify center of gravity and locate and describe mounting and anchorage provisions.
- c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

1.4 OPERATION AND MAINTENANCE MANUALS

- A. Provide contact information. The contact information shall include names, physical addresses, phone numbers and email addresses of the following:
 - 1. Installing company
 - 2. Specific contact person(s) for technical assistance, service and maintenance.
 - 3. Emergency contact information for after-hours technical assistance, service and maintenance.
- B. Provide a copy of the manufacturer's warranty.
- C. Provide a complete material and equipment list with corresponding part/model numbers.
- D. Provide an operation/user manual detailing operating instructions, programming instructions, maintenance requirements and trouble-shooting procedures.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications
 - 1. Installer must have personnel certified by BICSI on staff or certified by the material manufacturer to install their products.
 - 2. Installation Supervision
 - a. Installation shall be under the direct supervision of certified installer, who shall be present at all times when Work of this Section is performed at Project site.
- B. Telecommunications Pathways and Spaces: Comply with ANSI/TIA-569-C.
- C. Grounding: Comply with ANSI/TIA-607-B.
- D. Labeling: Comply with ANSI/TIA-606-B and UL 969 including label stocks, laminating adhesives and inks used by label printers.

PART 2 - PRODUCTS

2.1 PATHWAYS

- A. Cable Support:
 - 1. NRTL labeled.
 - 2. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable.
 - 3. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.

4. Straps and other devices. Cable straps shall be a reusable black Velcro cable wrap. No zip ties will be permitted.
5. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high and 2-1/2 inches deep.
6. Non-Continuous Pathways
 - a. J-Hooks
 - 1) Standard of Quality: B-line BCH32 (2"), BCH64 (4").
 - b. Penetrations through fire-rated assemblies:
 - 1) Provide STI EZ Path (44, 33 or 22 series) in conjunction with the tray.

2.2 BACKBOARDS

A. Backboards:

1. Plywood, fire-retardant treated, 3/4 inches thick by 96 inches tall.

2.3 EQUIPMENT FRAMES

A. Acceptable Manufacturers:

1. Legrand
2. Eaton/TrippLite
3. Middle Atlantic Products, Inc.
4. AMCO

B. General Frame Requirements:

1. Freestanding, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Width compatible with EIA 310-D standard, 19-inch panel mounting.
3. Manufacturer's standard, baked-polyester powder coat.

C. Floor-Mounted Channel Racks:

1. Modular-type, steel construction.
2. Vertical and horizontal cable management channels
3. Grounding lug
4. Baked-polyester powder coat finish.
5. Racks shall be 84 inches tall.
6. Vertical grounding bus bar.
7. Refer to drawings for quantity.
8. Channels constructed of 11-gauge steel.
9. Standard of Quality:
 - a. Legrand MightyMo 20 (Part # MM20710-B unless otherwise noted on drawings)

D. Wall Mounted Cabinets: Modular type, steel construction:

1. 24.5 inches tall, 20 inches deep, 26 inches wide.
2. Swing-out style

3. Provide one component shelf 14 inches deep and 3.5 inches tall.
4. Horizontal grounding bus bar.
5. Power strip.
6. Top, bottom and sides shall be vented.
7. Hinged and lockable, Plexiglas front door.
8. Swing open center section to allow front and rear access to equipment and cable.
9. Baked-polyester powder coat finish.
10. Electrical knockouts on top and bottom of backpan. Backpan shall have a large cutout for electrical pull box.
11. Standard of Quality:
 - a. Ortronics SWM12RUPL-26-26 (12RU), SWM26RUPL-26-26 (26RU)

E. Cable Management for Equipment Frames:

1. Integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Dual hinged latch doors
4. Standard of Quality:
 - a. Legrand MM20VMD706-B

F. Refer to the drawings for types and quantities of racks, cabinets or frames to be required.

2.4 POWER

A. Acceptable Manufacturers:

1. Eaton
2. Tripp Lite
3. Legrand/Middle Atlantic

B. Power Distribution Unit (PDU):

1. Comply with UL 1363.
2. Vertical mounted
3. TAA compliant
4. (24) 5-15/20R 120V outlets
5. LED indicator lights for power and protection status.
6. LED indicator lights for reverse polarity and open outlet ground.
7. Circuit Breaker and Thermal Fusing. When protection is lost, circuit opens and cannot be reset.
8. Cord connected with 10-foot line cord and a NEMA L5-20 plug.
9. Standard of Quality:
 - a. Eaton PDUMV20NETLX

2.5 GROUNDING

A. Telecommunications Main Bus Bar:

1. Connectors:
 - a. Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar:
 - a. Copper, minimum 1/4 inch thick by 4 inches wide by 20 inches long with 9/32-inch holes spaced 1-1/8 inches apart. (Legrand Part # GB4X20MGB)
3. Stand-Off Insulators:
 - a. Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.6 LABELING

- A. Labels shall be self-laminating and machine generated.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.
- B. Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.
- C. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
 1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
 2. Record agreements reached in meetings and distribute them to other participants.
 3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
 4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
- D. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 COMMUNICATION EQUIPMENT ROOM CONSTRUCTION

- A. Install telecommunications backboard on perimeter walls of each closet. Plywood sheets shall be installed vertically with the bottom installed at 12 inches above finished floor. Quantity of backboards shall be installed as required to cover all perimeter walls.
- B. Install ladder runway around perimeter of room. Extend ladder runway from perimeter to above each rack or cabinet and attach. Mount ladder runway above top of door frame. Coordinate exact height with conduit sleeves and other trades.
- C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

- D. Service entrance conduits shall extend no more than 6 inches above finished floor. Conduits shall be sealed.
- E. Securely attach distribution frames to floor.
 - 1. Provide seismic bracing per specifications.
- F. Grounding
 - 1. Install grounding bus bar in each closet.
 - 2. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Install a No. 4 AWG telecommunications bonding backbone from each room's grounding bus bar to the electrical grounding system at the main service entrance.
 - 3. Bond racks, cabinets and metal enclosures to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
 - 4. Bond the shield of shielded cable to the rack mounted grounding bus bar. Use a No. 12 AWG conductor unless the manufacturer requires otherwise.
 - 5. Bond patch panels to the rack mounted ground bus bar. Use a No. 12 AWG conductor unless the manufacturer requires otherwise.
 - 6. Bond metallic conduits and conduit sleeves, entering and within the room, to the grounding bus bar. Install conductor not smaller than No. 6 AWG.
- G. Label each rack with a unique identifier.

END OF SECTION 27 11 00

SECTION 27 15 00 – VOICE AND DATA COMMUNICATIONS CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to the general requirements specification, Section 26 05 00.
- B. Section Includes:
 - 1. Pathways.
 - 2. UTP cabling.
 - 3. Fiber Optic Cabling.
 - 4. Cable connecting hardware, patch panels, and cross-connects.
 - 5. Telecommunications outlet/connectors.
 - 6. Cabling system identification products.
 - 7. Cable management system.

1.2 SCOPE

- A. The intent of this specification section is to cover the materials and installation of a structured cabling system and termination equipment as outlined herein and as detailed on the drawings. Work shall consist of:
 - 1. Work area outlets including faceplates, jacks (voice, data, CATV, A/V), and labels provided by the Division 27 Contractor. Boxes and conduit are being provided by Div 26 contractor. Unless otherwise noted.
 - 2. Voice and data copper station cabling from work area outlets to telecommunications rooms including termination testing and labeling.
 - 3. Voice and data work area equipment cords.
 - 4. Voice and data horizontal cross-connect jumpers and patch cables including labeling.
- B. System Description - Voice and Data station cabling system shall consist of:
 - 1. Workstation outlet jacks.
 - 2. Voice and data station cabling as specified herein from each workstation outlet to the termination equipment located in the Main Distribution Frame (MDF) or the Intermediate Distribution Frame (IDF).
 - 3. Station Cable Termination Equipment in each MDF and IDF.
 - 4. Final connections of the station cabling at the workstation outlet jack and the termination equipment in each MDF and IDF.
 - 5. Cross connects / patch cable to connect work area outlets to backbone / network electronics.
 - 6. Testing and labeling.
- C. System Description – Backbone cabling system shall consist of:
 - 1. Fiber Optic and copper cabling as specified herein installed from the service entrance demarcation to the MDF or IDF, and then between all communications equipment rooms.
 - 2. Backbone termination equipment in each MDF and IDF.

3. Final connections of the backbone cabling at each MDF, IDF and service entrance demarcation.
4. Patch cables to connect the backbone cabling to the network electronics.
5. Testing and labeling.

1.3 SUBMITTALS

A. Product Data:

1. Provide the manufacturer's product data for each type of product indicated, including:
 - a. UTP cabling.
 - b. Fiber Optic Cabling
 - c. Connectors
 - d. Telecommunications outlets.
 - e. Patch panels.
 - f. Patch cords.

B. Qualification Data:

1. Provide copy of certifications for installer and installation supervisor.

1.4 OPERATION AND MAINTENANCE MANUALS

- A. Maintenance data for splices and connectors.
- B. Test Results, refer to Part 3 of this specification section.
- C. Warranty information.
- D. Cable schedule. Refer to "Installation" in Part 3 of this specification section. .

1.5 QUALITY ASSURANCE

A. Installer Qualifications, Cabling Installer shall:

1. Have BICSI certified technician on staff; RCDD on staff preferred.
2. Be certified by the material manufacturer to install their products.
3. Installation Supervision:
 - a. Installation shall be under the direct supervision of certified installer, who shall be present at all times when work of this section is performed at project site.
4. Be in business a minimum of five (5) years
5. Demonstrate satisfaction of sound financial condition and shall be adequately bonded and insured per owner's requirements.
6. Possess licenses/permits required to perform communications installations in the specified jurisdiction
7. Have personnel knowledgeable in local, state, province and national codes and regulations. All work shall comply with the latest revision of the codes and regulations. When conflict exists between local and national codes or regulations, the most stringent codes or regulations shall be followed.
8. Possess and provide proof of current owners insurance certificates

9. Have prior experience with this type of installation or work activity. The customer may, with full cooperation of the contractor, visit client installations to observe equipment operations and consult with references. Specified visits and discussion shall be arranged through the contractors; however, the contractor's personnel shall not be present during discussions with references. The contractor must provide a minimum of three (3) references of similar jobs, one within the past 6 months and one at least 3 years prior where the same solution was installed.
 10. Provide documentation of ALL certifications with the shop drawing submittal.
- B. General Performance: Horizontal cabling system shall comply with transmission standards in ANSI/TIA-568-C.1, when tested according to test procedures of this standard.
 - C. Telecommunications Pathways and Spaces: Comply with ANSI/TIA-569-C.
 - D. Grounding: Comply with ANSI/TIA-607-B.
 - E. Jacks: Comply with ANSI/TIA-568.2-D
 - F. UTP Cable: Comply with ANSI/TIA-568-C.2.
 - G. Labeling: Comply with ANSI/TIA-606-B.
 - H. Test equipment: Meet or exceed ANSI/TIA-568-C.2.

1.6 WARRANTY

- A. A warranty shall be provided for all internal infrastructure wiring as it pertains to voice and data networking for both copper and fiber systems. All installations must be performed according to the manufacturer's System Warranty and Performance Application.
- B. The warranty will combine an extended product and applications assurance warranty for a minimum of 25 years. The basis of design warranty for this specification is the nCompass warranty. Other warranties will be accepted as long as requirements throughout this specification are met.
- C. An Extended Product Warranty shall be provided which warrants functionality of all components used in the system from the date of registration. The Extended Product Warranty shall warrant the installed horizontal and/or backbone copper, and both the horizontal and the backbone optical fiber portions of the cabling system.
- D. The Application Assurance Warranty shall cover the failure of the wiring system to support the applications that are designed for the link/channel specifications of ANSI/TIA-568.1-D. These applications include, but are not limited to, 10BASE-T, 100BASE-T, 1000BASE-T, 40Gbps up to 400Gbps as required per system.

PART 2 - PRODUCTS

2.1 TWISTED PAIR CABLE AND HARDWARE

- A. Acceptable Manufacturers
 1. Superior Essex/Ortronics (Standard of Quality)
 2. Systimax
 3. Panduit/General Cable
- B. Horizontal/Station Cable:
 1. Category 6 Twisted Pair Cable shall have following specifications, minimum:
 - a. Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.
 - b. Comply with TIA-568.2-D for Category 6 cables.

- c. 100-ohm, 23 AWG solid copper conductors.
 - d. Must have an internal separator between pairs
 - e. Unshielded Twisted Pairs (UTP)
 - f. Plenum and indoor/outdoor rated
 - g. Refer to drawings for cable color requirements.
 - h. Standard of quality:
 - 1) Superior Essex DataGain+ Part #: 66-240-xA (riser) ; 66-240-xB (plenum) – “x” indicates color. Cable shall be indoor/outdoor rated where installed below slab or outdoor. Part #: 77-246-x1.
2. Category 6a Twisted Pair Cable:
- a. Four-pair, balanced twisted pair cable, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500 MHz.
 - b. Comply with TIA-568.2-D for Category 6a cables.
 - c. 100-ohm, 23 AWG solid copper conductors.
 - d. Must have internal separator between pairs
 - e. Unshielded Twisted Pairs (UTP)
 - f. Plenum and indoor/outdoor rated
 - g. Refer to drawings for cable color requirements.
 - h. Standard of quality:
 - 1) Superior Essex 10Gain XP+ Part #: 6B-246-xA (riser) ; 6B-246-xB (plenum) – “x” indicates color. Cable shall be indoor/outdoor rated where installed below slab or outdoor. Part #: 6F-272-ER.
- C. Twisted Pair Cable Hardware:
- 1. Cables shall be terminated with connecting hardware of the same category or higher.
 - 2. Comply with TIA-568.2-D, IDC type, with modules designed for punch down caps or tools.
 - 3. Patch Panels:
 - a. Unloaded panels designed to work with modular connectors.
 - b. Steel construction
 - c. Mountable on 19-inch equipment racks.
 - d. Labeling areas above each port.
 - e. 24 or 48 port configuration.
 - 1) Provide one port for each cable plus 25 percent spare ports. Spare ports are not per patch panel, but shall be based on the total cables terminated within the respective equipment rack ('per rack').
 - f. Cassette based
 - g. Front loading
 - h. Modular Design

- i. Unless otherwise shown on riser panels shall be installed with 24 ports of connectivity providing future growth up to 48 ports in 1RU
 - j. Standard of quality:
 - 1) Legrand LCS3 Part# 033683
- 4. Patch Cords:
 - a. Reduced Diameter Cat6 or Cat6A, provide appropriate cord to match horizontal cabling.
 - b. Factory-made, four pair cables, terminated with a modular plug at each end.
 - c. Bend-relief-compliant boots
 - d. Factory tested
 - e. Latch guards to protect against snagging.
 - f. Provide two (2) patch cables for each installed cable. Provide one for the workstation and one for the equipment room. Include 10% spare patch cords for both workstation and equipment room.
 - g. Lengths: shall be coordinated with owner's IT.
 - h. Standard of Quality:
 - 1) Legrand Small OD "Slim" patch cords.
- 5. Jacks:
 - a. Female, eight position, modular, fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair. Perform to a minimum of 250 MHz.
 - b. Designed to snap-in to a patch panel or cover plate.
 - c. Marked to indicate transmission performance.
 - d. Standard of Quality:
 - 1) CAT6: Legrand HDJ (HDJ6-XX, "XX" corresponds to color, refer to drawings)
 - 2) CAT6A: Legrand HDJ (HDJ6A-XX, "XX" corresponds to color, refer to drawings)
- 6. Faceplates:
 - a. Coordinate color and material type with Division 26 Section "Wiring Devices."
 - b. All device plates shall be four ports
 - 1) Color to match cover plate.
 - 2) Flush mounted jacks.
 - 3) Thermoplastic.
 - 4) Provide blank modules where port is not used, refer to drawings for required cables at each location.
 - c. Plates shall have label window that conceals screws.
 - d. Standard of Quality:

- 1) Legrand OR-403HDJ12 (2 port plastic), OR-403HDJ14 (4 port plastic), 403SHDJ12 (2 port Stainless Steel), 403SHDJ14 (4 port Stainless Steel)

2.2 OPTICAL FIBER

A. Acceptable Manufacturers

1. Superior Essex (Standard of Quality)
2. TiniFiber
3. Corning

B. Backbone Cable:

1. OM4 Multimode Optical Fiber Cable:

- a. TIA-492AAAD; 850 nm laser-optimized, 50 μ m core diameter, 125 μ m cladding diameter.
- b. Maximum attenuation dB/km @ 850/1300 nm: 3.5/1.5
- c. All fiber shall be plenum rated.
- d. Refer to Communication Riser for strand count.
Aqua jacket color.
- e. Standard of Quality:
 - 1) Superior Essex indoor L40xxP401, indoor/outdoor F460-0xxU30-E991. "xx" refers to strand count.

2. OS2 Single mode Optical Fiber Cable

- a. TIA-492AAAD; 9 μ m core diameter, 125 μ m cladding diameter, with low water peak.
- b. Maximum cabled attenuation dB/km @ 1310/1550 nm: 0.7/0.7
- c. All fiber shall be plenum rated.
- d. Refer to Communication Riser for strand count.
- e. Yellow jacket color.
- f. Standard of Quality:
 - 1) Superior Essex indoor L40xxK401, indoor/outdoor F460-0xxU13-E991. "xx" refers to strand count.

C. Patch Cords:

1. Factory-made, dual-fiber cables.
2. Provide (1) LC OM4 patch cord for each pair of fiber strands installed.
3. (3) foot lengths.

D. Optical Fiber Hardware

1. Hardware shall comply with the following:
 - a. Fiber Optic Connector Intermateability Standard (FOCIS) specifications of TIA-604 series.
 - b. TIA – 568.3
2. Fiber Optic Termination Hardware

- a. Rack Mounted Fiber Enclosures
 - 1) Fusion splicing shall be used (splice cassettes, pigtails, or splice on connectors)
 - 2) 1U Fiber enclosure standard of quality is the Legrand EQ01U-KHC, 2U EQ02U-KHC and 4U EQ04U-KHC
- b. Splice Cassettes (where indicated on drawings)
 - 1) Fusion splice cassette 50um Multimode 12 fiber LC (Part # OR-M4LCD12-50ES2A1)
 - 2) Fusion splice cassette singlemode 12 fiber LC (Part # OR-M4LCD12-09S1A1)
- 3. Connector Type:
 - a. Type LC
- 4. Fiber Optic Adapter Panels (used with pigtail or splice on connector terminations)
 - a. 6-LC Duplex multimode, aqua adapters, ceramic sleeve 12 fiber (Part # HDFP-LCD12LC)
 - b. 6-LC Duplex singlemode, blue adapters, ceramic sleeve 12 fiber (Part # HDFP-LCD12AC)
 - c. Blank filler modules (Part # HDFP-BLANK)
- 5. Fiber Optic Pigtails / Connectors

For fiber splicing, utilize Legrand 12 strand LC fiber pigtails or fusion splice on connectors.
- 6. Patch Panels
 - a. Modular panels housing multiple-numbered, LC duplex cable connectors.
 - b. Provide one connector for each fiber of cable, plus 25 percent blank positions.
- 7. Plug and Plug Assemblies:
 - a. Male, color-coded modular telecommunications connector designed for termination of single optical fiber cable.
 - b. Insertion loss not more than .25 dB.
 - c. Marked to indicated transmission performance.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate layout and installation of communications equipment with the Owner.
 - 1. Meet with the Owner to exchange information and agree on details of equipment arrangements and installation.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements.
 - 4. Adjust arrangements and locations of LAN/Communications equipment with other systems that share space in the communications equipment room (ex. security cameras, access control, fire alarm, etc.)

- B. Do not deliver or install equipment, cables and components, until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.
- C. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
 - 1. Refer to Division 26 specifications for raceway and box requirements.
- D. Coordinate cable and faceplate labeling with Owner's IT representative.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
 - 1. Comply with BICSI ITSIM, "Cable Termination Practices."
 - 2. Terminate conductors and cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 3. Cables may not be spliced.
 - 4. Cables shall not be painted. It will be the contractor's financial responsibility to replace any painted cables.
 - 5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
 - 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points.
 - 8. Bring cable to room temperature before unreeling. Heat lamps shall not be used for heating.
 - 9. Service Loops:
 - a. Station Cable:
 - 1) Communications equipment room – 10 feet.
 - 2) Workstation – 1 foot.
 - b. Backbone Cable
 - 1) Communications equipment room – 10 feet.
 - 10. Pulling Cable:
 - a. Comply with BICSI ITSIM, "Pulling Cable." Monitor cable pull tensions.
 - 11. Maintain a 1/2 inch (or less) untwist on UTP cables from the point of termination to maintain cable geometry.
 - 12. Group connecting hardware for cables into separate logical fields.
- C. Cable Installation.
 - 1. Install cables in raceways, cable trays, and J-hooks.
 - 2. Install plenum cable in environmental air spaces, including plenum ceilings.

3. All communications cabling shall be installed above grade, with the exception of where they are installed to floor boxes or island furnishings. Where cabling is installed below grade or in an exterior unconditioned space, the cable must be rated for outdoor location installation.
4. Wiring within Enclosures:
 - a. Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools
5. Secure and support cables more not than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Open-Cable Installation:
 - a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - b. Suspend cable not in a raceway or cable tray with J-hooks. J-hooks shall be installed a minimum of 8 inches above ceilings and not more than 36 inches apart.
 - c. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
 - d. Install fiber optic cables within inner-duct when not installed in conduit.
7. Installation of Cable Routed Exposed under Raised Floors:
 - a. Install plenum-rated cable only.
 - b. Install cabling after the flooring system has been installed in raised floor areas.
 - c. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.
- D. Separation from EMI Sources:
 1. Comply with BICSI TDMM 13th edition and ANSI/TIA-569-C for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

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 Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.
- E. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- F. Paint and label colors for equipment identification shall comply with ANSI/TIA-606-A.
- G. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- H. Cable and Wire Identification:
 1. Label each cable at each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated. Provide three labels at each end, spaced 12 inches apart. The first label shall be installed within four inches of the termination. Labels shall be visible from all sides of cable.
 2. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
 - b. Label each unit and field within distribution racks and frames.
 3. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
 4. Identify system components, wiring, and cabling complying with ANSI/TIA-606-B.
 - a. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
 5. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. Comply with Owner's labeling standard.
 - a. Coordinate labeling with owner.
 6. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in ANSI/TIA-606-B.
 - a. Use flexible vinyl or polyester, self-laminating, adhesive labels that flex as cables are bent.

3.3 FUNCTIONAL TESTING

A. Perform Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with ANSI/TIA-568-C.1.
2. Visually confirm cable, marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - a. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Test equipment basis of design is Fluke Networks.
4. UTP Cable Tests:
 - a. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance.
 - b. UTP performance test using a level IIe tester for Category 5e, level III tester for Category 6/6A and level IIIe for Category test cable. Test for each outlet and MUTOA. Perform the following tests according to ANSI/TIA-568-C.1 and ANSI/TIA-568-C.2:
 - 1) Wire map.
 - 2) Length (physical vs. electrical, and length requirements).
 - 3) Insertion loss.
 - 4) Near-end crosstalk (NEXT) loss.
 - 5) Power sum near-end crosstalk (PSNEXT) loss.
 - 6) Equal-level far-end crosstalk (ELFEXT).
 - 7) Power sum equal-level far-end crosstalk (PSELFEXT).
 - 8) Return loss.
 - 9) Propagation delay.
 - 10) Delay skew.
 - c. Continuity: Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity, and pair-reversals, crossed pairs and split pairs. Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests. The test shall be recorded as pass/fail as indicated by the test unit in accordance with the manufacturers' recommended procedures and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
 - d. Length: Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate.

The cable length shall conform to the maximum distances set forth in the ANSI/TIA 568-C Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.

- e. Final Certification Tests: Perform certification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
 - 1) Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
 - 2) Data Tests: Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.
- 5. Optical Fiber Cable Tests:
 - a. Test all optical fiber cable using an Optical Time Domain Reflectometer (OTDR).
 - b. Test instruments shall meet or exceed applicable requirements in ANSI/TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - c. Link End-to-End Attenuation Tests:
 - 1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to ANSI/TIA-526-14-A, Method B, One Reference Jumper.
 - 2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in ANSI/TIA-568-C.1.
- B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
 - 1. Upon completion of the installation, the telecommunications contractor shall provide three (3) full documentation sets to the Engineer for approval. Documentation shall include the items detailed in the sub-sections below.
 - 2. Documentation shall be submitted within ten (10) working days of the completion of each testing phase (e.g., subsystem, cable type, area, floor, etc.). This is inclusive of all test result and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase. At the request of the Engineer, the telecommunications contractor shall provide copies of the original test results.
 - 3. The Engineer may request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications contractor, additional testing can be required

to the extent determined necessary by the Engineer, including a 100% re-test.
This re-test shall be at no additional cost to the Owner.

3.4 OWNER TRAINING

- A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets.

END OF SECTION 27 15 00

SECTION 27 51 23 – INTERCOM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to the General Requirements Specifications, Section 260500.
- B. This section includes items pertaining to the intercom system, including but not limited to the following:
 - 1. Cabinets
 - 2. Software and Programming
 - 3. Speakers
 - 4. Cabling
- C. The intercom system will be referred to hereinafter as the “system.”

1.2 SCOPE

- A. The existing intercom system shall remain. The existing system is Rauland Telecenter U. New devices shall be connected to the existing system.
 - 1. The existing system is assumed to be fully functioning and operating properly in all its capacity.
 - 2. The existing system shall be tested prior to any modifications of the system. The contractor shall document in writing the condition, functionality and deficiencies of the system. The contractor shall provide a copy of this report to the design team and owner for review and comment.
 - 3. If the contractor fails to test the system and provide a written report prior to any modifications, and subsequently the existing system is found to have deficiencies, it will be the contractor's financial responsibility to make any and all corrections necessary to provide a fully functioning system.
- B. The system shall be an IP intercom and public address system.
 - 1. The system shall provide additional coverage where speakers are shown on floor plans in the Auxiliary Gymnasium expansion and surrounding common areas of the high school addition. The system shall be an extension of the existing high school intercom system.
 - 2. The system shall override the Auxiliary Gymnasium sound system and play incoming pages over the Auxiliary Gymnasium Sound system.
 - 3. No Intercom system shall be provided for any other buildings or areas on the project.
- C. Provide a complete and operational system as described within this specification and as shown on the contract drawings.
- D. All miscellaneous items and accessories required for a complete and operational system shall be provided whether or not each item is explicitly mentioned in these specifications or shown on the contract drawings
 - 1. The contractor is responsible for providing all line voltage circuits necessary for the operation of the system.
- E. Seismic
 - 1. Refer to the structural drawings and specifications for seismic design requirements.

2. Refer to the Seismic and Wind Controls for Electrical Systems specification, section 26 05 48 for additional requirements.
3. The specified work in this section must withstand the seismic hazard design loads for the installed elevation above and below grade.
 - a. The term 'withstand' means 'unit must remain in place without separation of parts from unit when subjected to specified seismic design and unit must be fully operational after seismic event'.

1.3 SUBMITTALS

- A. Product Data
 1. Provide the manufacturer's product data sheets for each component to be utilized on this project.
- B. Shop Drawings
 1. Provide shop drawings indicating the following:
 - a. Location of equipment and devices.
 - b. Interconnections between equipment and devices.
 - c. Riser/Wiring Diagrams.
 - d. Console/Rack layout
- C. Qualifications Data
 1. Person(s) performing the installation, programming and service of this system shall have, at a minimum, completed the manufacturer's training program(s) for the respective system to be installed. Provide certificate(s) of completion from the system manufacturer for person(s) performing this work.
- D. Seismic Performance Certificates
 1. Provide certificates for the equipment and accessories, from the manufacturer. Include the following:
 - a. Basis for Certification
 - 1) Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outlined Drawings of Equipment
 - 1) Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

1.4 OPERATION AND MAINTENANCE MANUALS

- A. Provide functional test results and certifications.
- B. Provide contact information. The contact information shall include names, physical addresses, phone numbers and email addresses of the following:
 1. Installing company
 2. Specific contact person(s) for technical assistance, service and maintenance.
 3. Emergency contact information for after-hours technical assistance, service and maintenance.
- C. Provide a copy of the owner training sign-in sheet.

- D. Provide a digital copy of the recording from the owner training session.
- E. Provide a copy of the manufacturer's warranty.
- F. Provide a complete material and equipment list with corresponding part/model numbers.
- G. Provide an operation/user manual detailing operating instructions, programming instructions, maintenance requirements and trouble-shooting procedures.

1.5 QUALITY ASSURANCE

- A. All equipment supplied for this system shall be the product of a single manufacturer, unless specifically noted otherwise.
- B. Installing Contractor:
 - 1. The contractor shall be a manufacturer's authorized representative, trained and approved for the installation of this system.
 - 2. The contractor shall have been in business for a minimum of 5 consecutive years prior to the date of this contract.
 - 3. The contractor shall have and maintain a fully equipment service department capable of providing inspections, service and repairs for the system.
- C. All materials, unless otherwise specified, shall be new and free from any defects.

1.6 WARRANTY

- A. The manufacturer shall warranty and agree to repair or replace all components that fail due to defects in material or workmanship for a period of 5 years starting from the date of substantial completion.
 - 1. The contractor shall be responsible for repairing or replacing all components that fail within one year of the date of substantial completion. The contractor will be financially responsible for the cost of material and labor for this period.
 - 2. The remainder of the warranty period shall apply to material costs only. Labor costs are excluded after the first year.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Owner preferred manufacturer:
 - 1. Rauland Telecenter U
- B. Equals:
 - 1. Bogen
 - 2. Atlas IED

2.2 PAGING SPEAKERS

- A. Recessed ceiling speaker
 - 1. 8" cone
 - 2. Self amplified with integral volume knob.
 - 3. Recessed ceiling mount, with hardware for lay-in 2x2 or 2x4 ACT or drywall ceiling
 - 4. Round perforated steel ceiling grill.
 - 5. Bright white finish
 - 6. Input Impedance: 2000 ohms
 - 7. Typical Input Sensitivity: 125 mV

8. Maximum Sound Pressure Level: 92 dB @ four feet on axis with 1W output at 1000 Hz
9. Dispersion: 90°
10. Equal to Bogen #ASWG1DK

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The system shall be installed according to this specification and the manufacturer's requirements.
- B. Cabling
 1. Cabling shall be installed in a similar manner as the communication cabling. Refer to specification sections Raceways and Boxes 260533, Communications Equipment Room 271100, Communications Backbone Cabling 271300, Communications Horizontal Cabling and the contract drawings for additional information.
 2. All cabling shall be installed in a minimum 3/4" conduit.
 - a. Cabling may be installed in open-air where located above concealed, accessible ceiling spaces.
 3. Cabling shall not be installed on or through the ceiling structure.
 4. All cabling shall be labeled using computer printed labels. Provide self-laminating adhesive labels made of vinyl or polyester that flex as cables are bent.
 - a. Each cable shall be labeled within 4 inches of each termination.
 - b. The label shall identify the location (room name and number) and type of device(s) the cables are connecting (Ex: Classroom 101, speaker).
 5. Splicing of category cable is not permitted.
- C. Refer to Division 26 specifications for the installation requirements of line voltage circuits, wiring devices, etc.
- D. Provide all necessary cutting and drilling of walls, floors, ceilings, etc. for the installation of the new work. No structural components shall be cut or modified unless specifically noted and/or approved by the architect/engineer.
- E. All work shall be protected during construction to prevent damage.
 1. Components shall not be installed until the building is dried-in.
 2. If the construction schedule requires the installation of the electronic components while dust producing activities are ongoing, the contractor shall protect the equipment with plastic or other means to prevent damage.
 - a. The equipment shall be thoroughly cleaned after the dust producing activities have ceased.
- F. Provide all programming, adjustments, etc.
 1. Adjust volume to the desired levels of the Owner.

3.2 FUNCTIONAL TESTING

- A. A factory authorized technician shall perform functional testing as recommended by the manufacturer. The technician shall confirm that the system is properly installed, free from defects and complies with the specifications.

1. Upon completion of the testing, the technician shall issue to the Owner a letter of certification attesting to the fact the he has tested and adjusted the system, that all components are properly installed and free of defects and that the system complies with the specifications.
2. A copy of this document shall be included in the O&M manual.

END OF SECTION 27 51 23

SECTION 27 60 00 – SOUND SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to General Requirements Specifications, Section 260500
- B. This section includes items pertaining to the local sound system(s), including but not limited to the following:
 - 1. Equipment Racks, Cabinets
 - 2. Amplifiers
 - 3. Digital Signal Processors
 - 4. Mixers
 - 5. Microphones – wired and wireless
 - 6. Assisted Listening
 - 7. Speakers
 - 8. Media Players
 - 9. Power Supplies and Sequencer
 - 10. Outlets
 - 11. Cabling

1.2 SCOPE

- A. General Description
 - 1. Weight Room
 - a. Provide a sound reinforcement for the Weight Room.
 - b. The headend components shall be installed in a floor mounted equipment cabinet.
 - 2. Baseball, Softball, Soccer and Football Field Sound System
 - a. These systems are to provide sound reinforcement for each field spectator areas and common areas. Multiple speakers controlled through shared DSP resources and multiple amplifiers are to be configured for each event to control the sound from the press box location.
 - b. The Main Head End Rack is to house Digital Signal Processing, Amplifiers, Wireless Microphone Receivers, Remote Wireless Microphone antenna, DSP Control, and Sequential Power Up System.
 - c. Press box is to house main equipment rack, Wired Microphone Input, Remote System Control, and CD/ IPOD Player.
 - d. For the football field sound system – provide input from the building voice evacuation fire alarm system to annunciate voice evacuation audio signal through the sound system speakers. Provide this system with UPS backup for 90 minutes. The system shall be seismically rated.
- B. Provide a complete and operational system as described within this specification and as shown on the contract drawings.
- C. All miscellaneous items and accessories required for a complete and operational system shall be provided whether or not each item is explicitly mentioned in these specifications or shown on the contract drawings.

1. The contractor is responsible for providing all line voltage circuits necessary for the operation of the system.

D. Seismic

1. Refer to the structural drawings and specifications for seismic design requirements.
2. Refer to the Seismic and Wind Controls for Electrical Systems specification, section 26 05 48 for additional requirements.
3. The specified work in this section must withstand the seismic hazard design loads for the installed elevation above and below grade.
 - a. The term 'withstand' means 'unit must remain in place without separation of parts from unit when subjected to specified seismic design and unit must be fully operational after seismic event'.

1.3 SUBMITTALS

A. Product Data

1. Provide the manufacturer's product data sheets for each component to be utilized on this project.

B. Shop Drawings

1. Provide shop drawings indicating the following:
 - a. Location of equipment and devices.
 - b. Interconnections between equipment and devices.
 - c. Riser/Wiring Diagrams.
 - d. Console/Rack layout
 - e. Loudspeaker suspension and mounting details.

C. Qualifications Data

1. Person(s) performing the installation, programming and service of this system shall have, at a minimum, completed the manufacturer's training program(s) for the respective system to be installed. Provide certificate(s) of completion from the system manufacturer for person(s) performing this work.

D. Seismic Performance Certificates

1. Provide certificates for the equipment and accessories, from the manufacturer. Include the following:
 - a. Basis for Certification
 - 1) Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outlined Drawings of Equipment
 - 1) Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

1.4 OPERATION AND MAINTENANCE MANUALS

- A. Provide functional test results and certifications.

- B. Provide contact information. The contact information shall include names, physical addresses, phone numbers and email addresses of the following:
 - 1. Installing company
 - 2. Specific contact person(s) for technical assistance, service and maintenance.
 - 3. Emergency contact information for after-hours technical assistance, service and maintenance.
- C. Provide a copy of the owner training sign-in sheet.
- D. Provide a digital copy of the recording from the owner training session.
- E. Provide a copy of the manufacturer's warranty.
- F. Provide a complete material and equipment list with corresponding part/model numbers.
- G. Provide an operation/user manual detailing operating instructions, programming instructions, maintenance requirements and trouble-shooting procedures.

1.5 QUALITY ASSURANCE

- A. All equipment supplied for this system shall be the product of a single manufacturer, unless specifically noted otherwise.
- B. Installing Contractor:
 - 1. The contractor shall be a manufacturer's authorized representative, trained and approved for the installation of this system.
 - 2. The contractor shall have been in business for a minimum of 5 consecutive years prior to the date of this contract.
 - 3. The contractor shall have and maintain a fully equipment service department capable of providing inspections, service and repairs for the system.
- C. All materials, unless otherwise specified, shall be new and free from any defects.

1.6 WARRANTY

- A. The manufacturer shall warranty and agree to repair or replace all components that fail due to defects in material or workmanship for a period of 5 years starting from the date of substantial completion.
 - 1. The contractor shall be responsible for repairing or replacing all components that fail within one year of the date of substantial completion. The contractor will be financially responsible for the cost of material and labor for this period.
 - 2. The remainder of the warranty period shall apply to material costs only. Labor costs are excluded after the first year.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Model numbers and manufacturers specified herein are basis of design and are not meant to exclude any manufacturers products from the project. Equal products from other manufacturers will be permitted once approved by the engineer.
- B. Submit equal products to the architect or engineer 10 days prior to bid.

2.2 EQUIPMENT

- A. Soccer Field Sound System
 - 1. Loudspeakers

- a. (4) QSC AcousticDesign AD-S12 — grandstand coverage
 - b. (2) QSC AcousticDesign AD-S8T — sideline fill
 - 2. Amplifiers
 - a. (1) QSC CX-Q 4K4
 - 3. DSP / Control
 - a. (1) QSC Q-SYS Core 110f
 - b. (1) Q-SYS network switch
 - 4. Inputs
 - a. (1) Shure SLXD24
 - b. (1) Shure MX418
- B. Football Field Sound System
 - 1. Loudspeakers
 - a. (6) QSC AcousticDesign AD-S12 — press box mounted, aimed at home stands
 - b. (2) QSC AcousticDesign AD-S10 — visitor side coverage
 - c. (2) QSC AcousticDesign AD-S28T — field / sideline coverage
 - d. (2) QSC AcousticDesign AD-S112SW — music reinforcement for events
 - e. Mounting apparatus is to be by AV contractor and coordinated prior to installation.
 - 2. Amplifiers
 - a. (2) QSC CX-Q 4K8
 - b. (1) QSC CX-Q 4K4
 - 3. DSP / Control
 - a. (1) QSC Q-SYS Core 110f
 - b. (1) QSC TSC-70-G3 — press box control
 - 4. Inputs / Announcer Equipment
 - a. (2) Shure ULXD4Q
 - b. (2) Shure ULXD2
 - c. (1) Shure MX418 — announcer booth
- C. Baseball and Softball Field Sound Systems
 - 1. The equipment listed herein shall be provided for each field.
 - 2. Loudspeakers
 - a. (2) QSC AcousticDesign AD-S10 — grandstand coverage
 - b. (2) QSC AcousticDesign AD-S8T — field / dugout coverage
 - 3. Amplifiers
 - a. (1) QSC CX-Q 2K4
 - 4. DSP / Control
 - a. (1) QSC Q-SYS Core 110f

- b. (1) Q-SYS network switch
- 5. Inputs
 - a. (1) Shure SLXD24
 - b. (1) Shure MX418

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate all system settings, sound levels, etc. with the Owner.

3.2 INSTALLATION

A. Cabling

- 1. Cabling shall be installed in a similar manner as the communication cabling. Refer to specification sections Raceways and Boxes 260533, Communications Equipment Room 271100, Communications Backbone Cabling 271300, Communications Horizontal Cabling and the contract drawings for additional information.
 - a. All cabling shall be installed in a minimum 3/4" conduit.
 - 1) Cabling may be installed in open-air where located above concealed, accessible ceiling spaces.
- 2. Cabling shall not be installed on or through the ceiling structure.
- 3. All cabling shall be labeled using computer printed labels. Provide self-laminating adhesive labels made of vinyl or polyester that flex as cables are bent.
 - a. Each cable shall be labeled within 4 inches of each termination.
 - b. The label shall identify the location (room name and number) and type of device(s) the cables are connecting (Ex: Gym, east speaker).
- 4. Splicing of cable is not permitted except in terminal cabinets and equipment housing.

- B. Refer to the Division 26 specifications for the installation requirements of line voltage circuits, wiring devices, etc.

- C. Provide all necessary cutting and drilling of walls, floors, ceilings, etc. for the installation of the new work. No structural components shall be cut or modified unless specifically noted and/or approved by the architect/engineer.

- D. All work shall be protected during construction to prevent damage.

- 1. Components shall not be installed until the building is dried-in.
- 2. If the construction schedule requires the installation of the electronic components while dust producing activities are ongoing, the contractor shall protect the equipment with plastic or other means to prevent damage.
 - a. The equipment shall be thoroughly cleaned after the dust producing activities have ceased.

- E. Provide all programming, adjustments, etc.

- 1. Adjust volume to the desired levels of the Owner.

- F. Provide mounting support for all speakers as recommended by the manufacturer.

- 1. Provide speakers with steel safety cabling for fall protection. The cabling shall be rated at a weight as recommended by the manufacturer.

2. Speakers located above a playing surface shall not be installed below the minimum height required by the Kentucky Department of Education.
- G. Rack Mounted Equipment to be located in a communications equipment racks shown on plans. For the field sound systems equipment, this will be located in the associated pressbox.

3.3 FUNCTIONAL TESTING

- A. Functional testing is to take place in a quiet environment without construction noise in the background or people coming in and out of the space. Allow four (4) hours for testing to be completed.
- B. Test all speaker cables prior to termination to amplifiers using an impedance meter and record the results of each home run. Speaker Line impedance shall not exceed amplifier specifications.
- C. Measure and record RT60 of room in final configuration with furniture and finishes.
- D. Utilizing calibrated Spectrum Analyzer, adjust response curve to as flat response as possible utilizing DSP Filters between 100 Hz to 6 kHz with a 3 dB per octave roll off above 6 kHz.
- E. Measure and record response curve, SPL, and STI measurements in a minimum of nine locations of the respective spaces. Measurements shall be taken at the left, right, center and front, middle, rear of the spaces.
 1. Measurements for tiered seating areas shall be taken from the front, middle and back rows at the far left, center, and far right positions.
- F. Sound Pressure Level recordings shall be A-weighted and not deviate more than 6 dB from front to back or side to side.
- G. STI measurements of .45 or lower shall constitute immediate notification to engineer.
- H. All recorded measurements are to be included with the O&M Manuals.

3.4 OWNER TRAINING

- A. Owner training shall not occur until the system is fully operational, software programmed and all punch list items are completed. If 3rd party commissioning is provided for the project, the owner training shall not occur until the resolution tracking form is completed.
- B. The presenter/trainer shall be a manufacturer's authorized representative familiar with the system(s).
- C. The contractor shall provide the following at a minimum for owner training:
 1. Sign-in sheet documenting the attendees and presenter's names and contact information.
 - a. Include the date and time the training occurred.
 2. A copy of the operation manual for the system shall be provided to each attendee.
 - a. The operation manual shall be reviewed with the attendees in conjunction with the physical demonstration of the system.
 3. Eight (8) hours total of in-service training.
 - a. The training time shall be divided into a minimum of two segments occurring on separate days.

4. The training shall be digitally recorded (audio and video). A copy of the recording shall be included with the O&M manual.

END OF SECTION 27 60 00

SECTION 27 70 00 – AUDIO/VISUAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to General Requirements Specifications, Section 260500
- B. This section includes items pertaining to the audio/visual (A/V) system(s), including but not limited to the following:
 - 1. Audio/Video Control Systems
 - 2. Sound-Field Amplification Systems
 - 3. Speakers
 - 4. Outlets
 - 5. Cabling

1.2 SCOPE

- A. General Description
 - 1. Auxiliary Gymnasium
 - a. Provide a sound-field amplification system where indicated on the drawings.
 - b. Connect the sound-field system to the intercom system. The sound-field system shall mute during an intercom page/announcement.
 - c. Connect the sound-field system to the local audio sources, computers and displays. The local audio sources shall broadcast through the sound-field system.
 - d. System shall support:
 - 1) Game-day announcements
 - 2) Music playback
 - 3) Wireless microphone use
 - 4) Even audio coverage across both courts
 - 5) Zoned control for flexible operation
 - e. System shall be based on a networked DSP platform with integrated amplification and control.
- B. Provide complete and operational systems as described within this specification and as shown on the contract drawings.
- C. All miscellaneous items and accessories required for complete and operational systems shall be provided whether or not each item is explicitly mentioned in these specifications or shown on the contract drawings.
 - 1. The contractor is responsible for providing all line voltage circuits necessary for the operation of the system.
- D. Seismic
 - 1. Refer to the structural drawings and specifications for seismic design requirements.
 - 2. Refer to the Seismic and Wind Controls for Electrical Systems specification, section 26 05 48 for additional requirements.

3. The specified work in this section must withstand the seismic hazard design loads for the installed elevation above and below grade.
 - a. The term 'withstand' means 'unit must remain in place without separation of parts from unit when subjected to specified seismic design and unit must be fully operational after seismic event'.

1.3 SUBMITTALS

A. Product Data

1. Provide the manufacturer's product data sheets for each component to be utilized on this project.

B. Shop Drawings

1. Provide shop drawings indicating the following:
 - a. Location of equipment and devices.
 - b. Interconnections between equipment and devices.
 - c. Riser/Wiring Diagrams.
 - d. Console/Rack layout
 - e. Mounting details.

C. Qualifications Data

1. Person(s) performing the installation, programming and service of this system shall have, at a minimum, completed the manufacturer's training program(s) for the respective system to be installed. Provide certificate(s) of completion from the system manufacturer for person(s) performing this work.

D. Seismic Performance Certificates

1. Provide certificates for the equipment and accessories, from the manufacturer. Include the following:
 - a. Basis for Certification
 - 1) Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outlined Drawings of Equipment
 - 1) Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

1.4 OPERATION AND MAINTENANCE MANUALS

A. Provide functional test results and certifications.

B. Provide contact information. The contact information shall include names, physical addresses, phone numbers and email addresses of the following:

1. Installing company
2. Specific contact person(s) for technical assistance, service and maintenance.
3. Emergency contact information for after-hours technical assistance, service and maintenance.

C. Provide a copy of the owner training sign-in sheet.

- D. Provide a digital copy of the recording from the owner training session.
- E. Provide a copy of the manufacturer's warranty.
- F. Provide a complete material and equipment list with corresponding part/model numbers.
- G. Provide an operation/user manual detailing operating instructions, programming instructions, maintenance requirements and trouble-shooting procedures.

1.5 QUALITY ASSURANCE

- A. Installing Contractor:
 - 1. The contractor shall be a manufacturer's authorized representative, trained and approved for the installation of this system.
 - 2. The contractor shall have been in business for a minimum of 5 consecutive years prior to the date of this contract.
 - 3. The contractor shall have and maintain a fully equipment service department capable of providing inspections, service and repairs for the system.
- B. All materials, unless otherwise specified, shall be new and free from any defects.

1.6 WARRANTY

- A. The manufacturer shall warranty and agree to repair or replace all components that fail due to defects in material or workmanship for a period of 5 years starting from the date of substantial completion.
 - 1. The contractor shall be responsible for repairing or replacing all components that fail within one year of the date of substantial completion. The contractor will be financially responsible for the cost of material and labor for this period.
 - 2. The remainder of the warranty period shall apply to material costs only. Labor costs are excluded after the first year.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Model numbers and manufacturers specified herein are basis of design and are not meant to exclude any manufacturers products from the project. Equal products from other manufacturers will be permitted once approved by the engineer.
- B. Submit equal products to the architect or engineer 10 days prior to bid.

2.2 EQUIPMENT

- A. DSP / CONTROL
 - 1. (1) QSC Q-SYS Core 110f
 - 2. (1) QSC TSC-70-G3 touchscreen controllers
- B. AMPLIFICATION
 - 1. (1) QSC CX-Q 8K4 network amplifier
 - 2. (1) QSC CX-Q 4K4 network amplifier
- C. LOUDSPEAKERS
 - 1. (10) QSC AcousticDesign AD-S12 surface-mount loudspeakers
 - 2. (4) QSC AcousticDesign AD-S162T column loudspeakers
 - 3. (2) QSC AcousticDesign AD-S112SW subwoofers

D. INPUTS / SOURCES

1. Provide and integrate the following inputs:
 - a. (2) Wireless handheld microphone systems (Shure SLXD or ULXD or approved equal)
 - b. (1) Gooseneck microphone at scorer's table
 - c. (1) Stereo program input (3.5mm and/or Bluetooth)
 - d. (1) Auxiliary input at scorer's table

E. All inputs shall be routed through DSP for mixing, EQ, and level control.

2.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide uniform SPL coverage across both courts and seating areas
- B. Achieve high speech intelligibility suitable for athletic announcements
- C. System shall be zoned at minimum as follows:
 1. Court A
 2. Court B
- D. Independent level control per zone
- E. System shall support simultaneous or independent operation of zones

2.4 SYSTEM FUNCTIONALITY

- F. Touchscreen interface shall provide:
 1. Source selection
 2. Zone volume control
 3. System mute / emergency mute
- G. DSP shall include:
 1. Equalization per zone
 2. Delay for time alignment
 3. Feedback suppression
 4. Limiting to protect loudspeakers
- H. Amplifiers shall be network-connected and monitored

2.5 INFRASTRUCTURE

- I. Contractor shall provide:
 1. Managed network switch for Q-SYS system
 2. UPS for DSP and control equipment

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate all system settings, sound levels, etc. with the Owner.

3.2 INSTALLATION

- A. Cabling
 1. Cabling shall be installed in a similar manner as the communication cabling. Refer to specification sections Raceways and Boxes 260533, Communications

Equipment Room 271100, Communications Backbone Cabling 271300, Communications Horizontal Cabling and the contract drawings for additional information.

- a. All cabling shall be installed in a minimum 3/4" conduit.
 - 1) Cabling may be installed in open-air where located above concealed, accessible ceiling spaces.
2. Cabling shall not be installed on or through the ceiling structure.
3. All cabling shall be labeled using computer printed labels. Provide self-laminating adhesive labels made of vinyl or polyester that flex as cables are bent.
 - a. Each cable shall be labeled within 4 inches of each termination.
 - b. The label shall identify the location (room name and number) and type of device(s) the cables are connecting (Ex: Classroom 123, east speaker).
4. Splicing of cable is not permitted except in terminal cabinets and equipment housing.
- B. Refer to the Division 26 specifications for the installation requirements of line voltage circuits, wiring devices, etc.
- C. Provide all necessary cutting and drilling of walls, floors, ceilings, etc. for the installation of the new work. No structural components shall be cut or modified unless specifically noted and/or approved by the architect/engineer.
- D. All work shall be protected during construction to prevent damage.
 1. Components shall not be installed until the building is dried-in.
 2. If the construction schedule requires the installation of the electronic components while dust producing activities are ongoing, the contractor shall protect the equipment with plastic or other means to prevent damage.
 - a. The equipment shall be thoroughly cleaned after the dust producing activities have ceased.
- E. Provide all programming, adjustments, etc.
- F. Provide mounting support for all speakers as recommended by the manufacturer.
 1. Provide speakers with steel safety cabling for fall protection. The cabling shall be rated at a weight as recommended by the manufacturer.
 2. Speakers located above a playing surface shall not be installed below the minimum height required by the Kentucky Department of Education.

3.3 FUNCTIONAL TESTING

- A. Provide functional testing to demonstrate the following to the Owner/Engineer:
 1. The systems function as specified.
 2. Sound systems are set at the Owner's desired levels.
 3. Displayed images are clear and are the correct size.

3.4 OWNER TRAINING

- A. Owner training shall not occur until the system is fully operational, software programmed and all punch list items are completed. If 3rd party commissioning is provided for the project, the owner training shall not occur until the resolution tracking form is completed.
- B. The presenter/trainer shall be a manufacturer's authorized representative familiar with the system(s).

- C. The contractor shall provide the following at a minimum for owner training:
1. Sign-in sheet documenting the attendees and presenter's names and contact information.
 - a. Include the date and time the training occurred.
 2. A copy of the operation manual for the system shall be provided to each attendee.
 - a. The operation manual shall be reviewed with the attendees in conjunction with the physical demonstration of the system.
 3. Eight (8) hours total of in-service training.
 - a. The training time shall be divided into a minimum of two segments occurring on separate days.
 4. The training shall be digitally recorded (audio and video). A copy of the recording shall be included with the O&M manual.

END OF SECTION 27 70 00

SECTION 28 14 00 – ACCESS CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to General Requirements Specifications, Section 260500
- B. This section includes items pertaining to the access control system(s), including but not limited to the following:
 - 1. Controllers
 - 2. Card Readers
 - 3. Power Supplies

1.2 SCOPE

- A. The existing access control system(s) shall remain the existing system is Gallagher Command Centre. New devices shall be connected to the existing system..
 - 1. The existing system(s) is assumed to be fully functioning and operating properly in all its capacity.
 - 2. The existing system(s) shall be tested prior to any modifications of the system. The contractor shall document in writing the condition, functionality and deficiencies of the system(s). The contractor shall provide a copy of this report to the design team and owner for review and comment.
 - 3. If the contractor fails to test the system(s) and provide a written report prior to any modifications, and subsequently the existing system(s) is found to have deficiencies, it will be the contractor's financial responsibility to make any and all corrections necessary to provide a fully functioning system.
- B. Provide a complete and operational system as described within this specification and as shown on the contract drawings.
- C. All miscellaneous items and accessories required for a complete and operational system shall be provided whether or not each item is explicitly mentioned in these specifications or shown on the contract drawings.
 - 1. The contractor is responsible for providing all line voltage circuits necessary for the operation of the system.

1.3 SUBMITTALS

- A. Product Data
 - 1. Provide the manufacturer's product data sheets for each component to be utilized on this project.
- B. Shop Drawings
 - 1. Provide shop drawings indicating the following:
 - a. Location of equipment and devices.
 - b. Interconnections between equipment and devices.
 - c. Riser/Wiring Diagrams.
- C. Qualifications Data
 - 1. Person(s) performing the installation, programming and service of this system shall have, at a minimum, completed the manufacturer's training program(s) for the

respective system to be installed. Provide certificate(s) of completion from the system manufacturer for person(s) performing this work.

1.4 OPERATION AND MAINTENANCE MANUALS

- A. Provide functional test results and certifications.
- B. Provide contact information. The contact information shall include names, physical addresses, phone numbers and email addresses of the following:
 - 1. Installing company
 - 2. Specific contact person(s) for technical assistance, service and maintenance.
 - 3. Emergency contact information for after-hours technical assistance, service and maintenance.
- C. Provide a copy of the owner training sign-in sheet.
- D. Provide a digital copy of the recording from the owner training session.
- E. Provide a copy of the manufacturer's warranty.
- F. Provide a complete material and equipment list with corresponding part/model numbers.
- G. Provide an operation/user manual detailing operating instructions, programming instructions, maintenance requirements and trouble-shooting procedures.
- H. Provide software, including system restore, emergency boot diskettes, and drivers for all installed hardware.

1.5 QUALITY ASSURANCE

- A. All equipment supplied for this system shall be the product of a single manufacturer, unless specifically noted otherwise.
- B. Installing Contractor:
 - 1. The contractor shall be a manufacturer's authorized representative, trained and approved for the installation of this system.
 - 2. The contractor shall have been in business for a minimum of 5 consecutive years prior to the date of this contract.
 - 3. The contractor shall have and maintain a fully equipment service department capable of providing inspections, service and repairs for the system.
- C. All materials, unless otherwise specified, shall be new and free from any defects.

1.6 WARRANTY

- A. The manufacturer shall warranty and agree to repair or replace all components that fail due to defects in material or workmanship for a period of 5 years starting from the date of substantial completion.
 - 1. The contractor shall be responsible for repairing or replacing all components that fail within one year of the date of substantial completion. The contractor will be financially responsible for the cost of material and labor for this period.
 - 2. The remainder of the warranty period shall apply to material costs only. Labor costs are excluded after the first year.

PART 2 - PRODUCTS

2.1 CARD READER

- A. Acceptable Manufacturers
 - 1. Gallagher Security

- B. Multitech reader equal to Gallagher T11. Mullion mount Gallagher T15

2.2 CONTROLLERS

- A. Acceptable manufacturers
 - 1. Gallagher Security
- B. Shall be equal to Gallagher 7000 Controller

2.3 PANELS

- A. Acceptable Manufacturers
 - 1. Life Safety Power
 - 2. Approved Equal
- B. Features:
 - 1. Nema 1 steel enclosure
 - 2. Black
 - 3. Internal cable management
 - 4. Integral battery backup for 90 minutes of operation of all devices plus 25% additional capacity.

2.4 INPUT/OUTPUT MODULES

- A. Acceptable Manufacturers
 - 1. Mercury
 - 2. Approved Equal
- B. Open architecture.
- C. Provide quantity of inputs and outputs as required by devices shown on drawings plus 25% additional spare inputs and outputs at all panel locations.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate the installation with the door hardware installer and the Owner's I.T. representative.

3.2 INSTALLATION

- A. Cabling
 - 1. Cabling shall be installed in a similar manner as the communication cabling. Refer to specification sections Raceways and Boxes 260533, Communications Equipment Room 271100, Communications Backbone Cabling 271300, Communications Horizontal Cabling 271500 and the contract drawings for additional information.
 - a. All cabling shall be installed in a minimum 3/4" conduit.
 - 1) Cabling may be installed in open-air where located above concealed, accessible ceiling spaces.
 - 2. Cabling shall not be installed on or through the ceiling structure.
 - 3. All cabling shall be labeled using computer printed labels. Provide self-laminating adhesive labels made of vinyl or polyester that flex as cables are bent.
 - a. Each cable shall be labeled within 4 inches of each termination.

- b. The label shall identify the location (Door Number) and type of device(s) the cables are connecting (Ex: Door 123, Door Controller).
 - 4. Splicing of cable is not permitted except in terminal cabinets and equipment housing.
- B. Refer to the Division 26 specifications for the installation requirements of line voltage circuits, wiring devices, etc.
- C. Provide all necessary cutting and drilling of walls, floors, ceilings, etc. for the installation of the new work. No structural components shall be cut or modified unless specifically noted and/or approved by the architect/engineer.
- D. All work shall be protected during construction to prevent damage.
 - 1. Components shall not be installed until the building is dried-in.
 - 2. If the construction schedule requires the installation of the electronic components while dust producing activities are ongoing, the contractor shall protect the equipment with plastic or other means to prevent damage.
 - a. The equipment shall be thoroughly cleaned after the dust producing activities have ceased.
- E. Provide all programming necessary for a complete and operational system. Enroll and prepare badges and access cards for all of the Owner's designated personnel.

3.3 FUNCTIONAL TESTING

- A. Functional Testing:
 - 1. LAN Cables: Inspect for physical damage and test each conductor signal path for continuity and shorts. Test for faulty connectors and terminations. Refer to the Communications specification sections 271100, 271300 and 271500 for additional testing and documentation requirements.
 - 2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time.
 - 3. Demonstrate to the Owner/Engineer the systems function as specified.
 - 4. Document test and inspections with written reports and include in the Operation and Maintenance Manuals.

3.4 OWNER TRAINING

- A. Owner training shall not occur until the system is fully operational, software programmed, and all punch list items are completed. If 3rd party commissioning is provided for the project, the owner training shall not occur until the resolution tracking form is completed.
- B. The presenter/trainer shall be a manufacturer's authorized representative familiar with the system(s).
- C. The contractor shall provide the following at a minimum for owner training:
 - 1. Sign-in sheet documenting the attendees and presenter's names and contact information.
 - a. Include the date and time the training occurred.
 - 2. A copy of the operation manual for the system shall be provided to each attendee.

- a. The operation manual shall be reviewed with the attendees in conjunction with the physical demonstration of the system.
- 3. Eight (8) hours total of in-service training.
 - a. The training time shall be divided into a minimum of two segments occurring on separate days.
- 4. The training shall be digitally recorded (audio and video). A copy of the recording shall be included with the O&M manual.

END OF SECTION 28 14 00

SECTION 28 23 00 – VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to General Requirements Specifications, Section 260500
- B. This section includes items pertaining to the video surveillance system(s), including but not limited to the following:
 - 1. Cameras

1.2 SCOPE

- A. The existing video surveillance system(s) shall remain, the existing system is Milestone X-protect. New devices shall be connected to the existing system.
 - 1. The existing system(s) is assumed to be fully functioning and operating properly in all its capacity.
 - 2. The existing system(s) shall be tested prior to any modifications of the system. The contractor shall document in writing the condition, functionality and deficiencies of the system(s). The contractor shall provide a copy of this report to the design team and owner for review and comment.
 - 3. If the contractor fails to test the system(s) and provide a written report prior to any modifications, and subsequently the existing system(s) is found to have deficiencies, it will be the contractor's financial responsibility to make any and all corrections necessary to provide a fully functioning system.
- B. General Description
 - 1. Provide an IP based video surveillance system consisting of servers, network cameras and connect to the video management system.
 - 2. Provide NVR storage to record and store video for a minimum of 30 days for new cameras.
 - 3. Provide all necessary licenses.
- C. Provide a complete and operational system as described within this specification and as shown on the contract drawings.
- D. All miscellaneous items and accessories required for a complete and operational system shall be provided whether or not each item is explicitly mentioned in these specifications or shown on the contract drawings.
 - 1. The contractor is responsible for providing all line voltage circuits necessary for the operation of the system.

1.3 SUBMITTALS

- A. Product Data
 - 1. Provide the manufacturer's product data sheets for each component to be utilized on this project.
- B. Shop Drawings
 - 1. Provide shop drawings indicating the following:
 - a. Floor plans indicating the location of equipment and devices.
 - b. Interconnections between equipment and devices.
 - c. Riser/Wiring Diagrams.

- d. UPS sizing calculations
 - e. Video storage calculations
- C. Qualifications Data
 - 1. Person(s) performing the installation, programming and service of this system shall have, at a minimum, completed the manufacturer's training program(s) for the respective system to be installed. Provide certificate(s) of completion from the system manufacturer for person(s) performing this work.

1.4 OPERATION AND MAINTENANCE MANUALS

- A. Provide functional test results and certifications.
- B. Provide contact information. The contact information shall include names, physical addresses, phone numbers and email addresses of the following:
 - 1. Installing company
 - 2. Specific contact person(s) for technical assistance, service and maintenance.
 - 3. Emergency contact information for after-hours technical assistance, service and maintenance.
- C. Provide a copy of the owner training sign-in sheet.
- D. Provide a digital copy of the recording from the owner training session.
- E. Provide a copy of the manufacturer's warranty.
- F. Provide a complete material and equipment list with corresponding part/model numbers.
- G. Provide an operation/user manual detailing operating instructions, programming instructions, maintenance requirements and trouble-shooting procedures.
- H. Provide copies of software and drivers for all installed hardware.

1.5 QUALITY ASSURANCE

- A. All equipment supplied for this system shall be the product of a single manufacturer, unless specifically noted otherwise.
- B. Installing Contractor:
 - 1. The contractor shall be a manufacturer's authorized representative, trained and approved for the installation of this system.
 - 2. The contractor shall have been in business for a minimum of 5 consecutive years prior to the date of this contract.
 - 3. The contractor shall have and maintain a fully equipment service department capable of providing inspections, service, and repairs for the system.
- C. All materials, unless otherwise specified, shall be new and free from any defects.

1.6 WARRANTY

- A. The manufacturer shall warranty and agree to repair or replace all components that fail due to defects in material or workmanship for a period of 5 years starting from the date of substantial completion.
 - 1. The contractor shall be responsible for repairing or replacing all components that fail within one year of the date of substantial completion. The contractor will be financially responsible for the cost of material and labor for this period.
 - 2. The remainder of the warranty period shall apply to material costs only. Labor costs are excluded after the first year.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Hanwha (Basis of Design)
- B. Axis
- C. Bosch

2.2 OUTDOOR AND GYM IP DOME CAMERA

- A. Hanwha XNV-C8083R
 - 1. 6MP resolution
 - 2. 4.4~9.3mm (2.1x) motorized varifocal
 - 3. Color: 0.04 Lux (F1.3, 1/30sec, 30IRE), 0 Lux (IR LED on)
 - 4. Maximum 30 fps (H.265/H.264)
 - 5. WiselR: IR viewable length 40 m (131.23 ft)
 - 6. Day & Night (ICR), extremeWDR (120 dB)
 - 7. Hard-coated dome
 - 8. WiseNR(Based on AI engine), WiseStream III(Based on AI engine)
 - a. Analytics events based on AI engine (NPU) : Object detection (Person/Face/Vehicle - car, truck, bus, bicycle, motorcycle/License plate)
 - 9. IVA (Virtual line/Area, Enter/Exit, Loitering, Direction, Intrusion)
 - 10. Analytics events : Defocus detection, Motion detection, Tampering, Fog detection
 - 11. Audio detection, Sound classification, Shock detection, Appear/Disappear
 - 12. IP66, NEMA4X, IK10

2.3 INDOOR IP DOME CAMERA

- A. Hanwha XND-A8084RV

2.4 IP 180 DEGREE DOME CAMERA

- A. Hanwha PNM-A13022RV
 - 1. 8MP 5120X1568 resolution
 - 2. 209° panoramic stitching image
 - 3. IR viewable length Maximum 20m (65.6ft),
 - 4. 20fps at all resolutions (H.265/H.264/MJPEG)
 - 5. MJPEG codec, WiseStream III supported
 - 6. WiseNR II (Based on AI engine)
 - a. Analytics events based on AI engine: Object classification (Person/Vehicle), Virtual line (Crossing/Direction), Virtual area (Loitering/Intrusion/Enter/Exit)
 - 7. Standard analytic events: Defocus detection, Motion detection, Tampering, Audio detection, Sound classification, Virtual area (Appear/Disappear)
 - 8. micro SD/SDHC/SDXC 2 slots,
 - 9. PoE+/12v DC

10. IP66, IK10, Hard coated dome

2.5 IP DUAL SENSOR DOME CAMERA

A. Hanwha PNM-C12083RVD

1. 6MP X 2 sensors, each at 15fps with a 3.4~6.8mm(2x) (95.08°~47.64°) motorized varifocal lens, Triple codec (H.265/H.264/MJPEG).
2. IR viewable length is 25m (82ft)
3. Day & Night (ICR)
4. extremeWDR (120dB)
5. DIS, & Handover
6. Analytics events based on AI engine: Object detection(Person/Face/Vehicle/License plate), IVA (Virtual line/Area, Enter/Exit, Loitering, direction, intrusion)
7. Analytics events : Defocus detection, Motion detection, Tampering, Audio detection, Sound classification, Appear/Disappear.
8. FIPS 140-2 compliant
9. micro SD card slot supports up to 512GB
10. IP66, NEMA4X, IK10
11. Operating temperature: -40°C~+55°C(-40°F ~ +131°F)
12. Power: PoE+
13. Metal shielded RJ-45, Hard-coated dome

2.6 IP BULLET ZOOM CAMERA

A. Hanwha PNO-A9311R

2.7 CABLING

- A. Refer to 27 15 00 - Voice and Data Communications Cabling for cabling requirements.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate the installation of servers, UPS's, patch panels, etc. with the Owner's IT representative.
- B. Coordinate the field-of-view of cameras with the designated Owner's representative.
- C. Provide on-site assistance in adjusting the system to suit actual occupied conditions when requested within 12 months of substantial completion. Provide (3) site visits during other-than-normal occupancy hours for this purpose.

3.2 INSTALLATION

A. Cabling

1. Cabling shall be installed in a similar manner as the communication cabling. Refer to specification sections Raceways and Boxes 260533, Communications Equipment Room 271100, Communications Backbone Cabling 271300, Communications Horizontal Cabling 271500, and the contract drawings for additional information.
 - a. All cabling shall be installed in a minimum 3/4" conduit.

- 1) Cabling may be installed in open-air where located above concealed, accessible ceiling spaces.
2. Cabling shall not be installed on or through the ceiling structure.
3. All cabling shall be labeled using computer printed labels. Provide self-laminating adhesive labels made of vinyl or polyester that flex as cables are bent.
 - a. Each cable shall be labeled within 4 inches of each termination.
 - b. The label shall identify the location (Room name and Number) and type of device(s) the cables are connecting (Ex: Corridor 123, Camera).
4. Splicing of cable is not permitted.
- B. Refer to the Division 26 specifications for the installation requirements of line voltage circuits, wiring devices, etc.
- C. Provide all necessary cutting and drilling of walls, floors, ceilings, etc. for the installation of the new work. No structural components shall be cut or modified unless specifically noted and/or approved by the architect/engineer.
- D. All work shall be protected during construction to prevent damage.
 1. Components shall not be installed until the building is dried-in.
 2. If the construction schedule requires the installation of the electronic components while dust producing activities are ongoing, the contractor shall protect the equipment with plastic or other means to prevent damage.
 - a. The equipment shall be thoroughly cleaned after the dust producing activities have ceased.
- E. Provide all programming necessary for a complete and operational system.
- F. Install cameras and infrared illuminators level and plumb.
- G. Install power supplies and other auxiliary components at control stations (MDF/IDF where cabling originates) unless otherwise indicated.
- H. Align and adjust system. Conduct tests at varying lighting levels, including day and night scenes.
 1. Verify operation of auto-iris lenses.
 2. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without filter.
 3. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50'-75' away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
 4. Set and name all preset positions. Coordinate presets with the Owner's designated personnel.
 5. Set sensitivity of motion detection.
 6. Connect and verify responses to alarms.

3.3 FUNCTIONAL TESTING

- A. Functional Testing:
 1. Provide testing and certifications recommended by the manufacturer.
 2. LAN Cables: Inspect for physical damage and test each conductor signal path for continuity and shorts. Test for faulty connectors and terminations. Refer to the

Communications specification sections 271100, 271300 and 271500 for additional testing and documentation requirements.

3. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time.
4. Demonstrate to the Owner/Engineer the systems function as specified.
5. Document test and inspections with written reports and include in the Operation and Maintenance Manuals.

3.4 OWNER TRAINING

- A. Owner training shall not occur until the system is fully operational, software programmed, and all punch list items are completed. If 3rd party commissioning is provided for the project, the owner training shall not occur until the resolution tracking form is completed.
- B. The presenter/trainer shall be a manufacturer's authorized representative familiar with the system(s).
- C. The contractor shall provide the following at a minimum for owner training:
 1. Sign-in sheet documenting the attendees and presenter's names and contact information.
 - a. Include the date and time the training occurred.
 2. A copy of the operation manual for the system shall be provided to each attendee.
 - a. The operation manual shall be reviewed with the attendees in conjunction with the physical demonstration of the system.
 3. Eight (8) hours total of in-service training.
 - a. The training time shall be divided into a minimum of two segments occurring on separate days.
 4. The training shall be digitally recorded (audio and video). A copy of the recording shall be included with the O&M manual.

END OF SECTION 28 23 00

SECTION 28 31 11 – DIGITAL, ADDRESSABLE VOICE EVACUATION TYPE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to the General Requirements specification, Section 26 05 00.
- B. Section Includes:
 - 1. Fire-alarm control unit (FACU).
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Nonsystem smoke detectors.
 - 5. Heat detectors.
 - 6. Notification appliances.
 - 7. Magnetic door holders.
 - 8. Remote annunciator.
 - 9. Addressable interface device.
 - 10. Communicator transmitter.

1.2 SCOPE

- A. Provide noncoded, UL-certified addressable system, with multiplexed signal transmission and voice and strobe notification for evacuation.
 - 1. System shall comply with NFPA 72.
 - 2. New equipment indicated to be connected to an existing FACU/system shall be fully compatible with the existing system.
 - 3. The existing system is Simplex 4100ES with voice evac.
 - 4. Provide all necessary components to interface the new equipment to the existing system.
- B. Provide a complete and operational system as described within this specification and as shown on the contract drawings.
- C. All miscellaneous items and accessories required for a complete and operational system shall be provided whether or not each item is explicitly mentioned in these specifications or shown on the contract drawings.
 - 1. The contractor is responsible for providing all line voltage circuits necessary for the operation of the system.
- D. Seismic:
 - 1. Refer to the structural drawings and specifications for seismic design requirements.
 - 2. Refer to the Vibration and Seismic Controls for Electrical Systems specification, section 26 05 48 for additional requirements.
 - 3. The specified work in this section must withstand the seismic hazard design loads for installed elevation above and below grade.
 - a. The term 'withstand' means 'unit must remain in place without separation of parts from unit when subjected to specified seismic design loads and unit must be fully operational after seismic event.'

1.3 SUBMITTALS

A. Product Data

1. Provide the manufacturer's product data sheets for each component to be utilized on this project.

B. Shop Drawings:

1. The contract documents establish the required system type and detail the system's operational and performance requirements. The final design and engineering of the fire alarm system is delegated to the contractor.
 - a. The contractor shall prepare complete design documents as required by the Authority Having Jurisdiction (AHJ) and as outlined in the documentation section of NFPA 72.
 - b. The contractor shall submit the design documents to the AHJ and the engineer.
 - c. Provide the following additional information:
 - 1) 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.
 - 2) 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.
 - 3) Indicate address of each addressable device.
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 III minimum.
 - c. Licensed or certified by authorities having jurisdiction.

C. Seismic Performance Certificates:

1. Provide certificates for FACU, accessories, and components, from manufacturer. Include the following information:
 - a. Basis for Certification:
 - 1) Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outlined Drawings of Equipment Unit:
 - 1) Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

1.4 OPERATION AND MAINTENANCE MANUALS

- A. Provide contact information. The contact information shall include names, physical addresses, phone numbers and email addresses of the following:

1. Installing company
 2. Specific contact person(s) for technical assistance, service and maintenance.
 3. Emergency contact information for after-hours technical assistance, service and maintenance.
- B. Provide a copy of the owner training sign-in sheet.
- C. Provide a digital copy of the recording from the owner training session.
- D. Provide a copy of the manufacturer's warranty.
- E. Provide a complete material and equipment list with corresponding part/model numbers.
- F. Provide an operation/user manual detailing operating instructions, programming instructions, maintenance requirements and trouble-shooting procedures.
1. Comply with the requirements of NFPA 72.
- G. Provide Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
 2. Program Software Backup complete with data files.
 3. Device address list.
 4. Printout of software application and graphic screens.
- H. Provide a copy of the testing, inspection, and record of completion documentation.

1.5 QUALITY ASSURANCE

- A. Installer must be a factory authorized representative of the fire alarm system manufacturer.
1. The installer in responsible charge shall be a minimum Level II fire alarm technician.
- B. Obtain fire-alarm system from single source from single manufacturer.
- C. For projects that require interfacing with an existing system, the new components shall be compatible with, and operate as, an extension of existing system.
- D. All fire alarm equipment and cabling shall be listed and labeled by an NRTL for fire alarm use in accordance with NFPA 72.

1.6 WARRANTY

- A. The manufacturer shall warranty and agree to repair or replace all components that fail due to defects in material or workmanship for a period of 1 year starting from the date of substantial completion.
1. The contractor will be financially responsible for the cost of material and labor for this period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. JCI/Simplex

2.2 GENERAL REQUIREMENTS

- A. Provide alarm, supervisory, and trouble signal initiation from all devices required by NFPA 72 and as indicated in the contract documents.

- B. Provide alarm supervisory, and trouble signal actions as required by NFPA 72 and as indicated in the contract documents.
- C. Circuits:
 - 1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.
 - a. Initiating Device Circuits: Style D.
 - b. Notification Appliance Circuits: Style Z.
 - c. Signaling Line Circuits: Style 5.
 - d. Install no more than 50 addressable devices on each signaling line circuit.
- D. Smoke-Alarm Verification:
 - 1. Only permitted to be utilized at locations where specifically noted on the drawings.
 - a. When permitted, activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.

2.3 FIRE-ALARM CONTROL UNIT

- A. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
 - 1. 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.
 - 2. Include a real-time clock for time annotation of events on the event recorder.
- 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 shall be a liquid-crystal (LCD) type, with 3 line(s) of 80 characters, minimum.
 - 2. Keypad shall be arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
- C. 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.
- D. Voice-Alarm:
 - 1. Control emergency communication system with redundant microphones, preamplifiers, amplifiers and tone generators provided in a module that is part of the FACU.
 - 2. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of central-control microphone. Amplifiers must comply with UL 1711.

- a. Allow application of, and evacuation signal to indicate number of zones and simultaneously allow voice paging to other zones selectively or in combination.
 - b. Programmable tone on message sequence selection.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear".
 - d. 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 the FACU.
- 3. Status annunciator: Indicate status of various voice/alarm speaker zones and status of firefighters' two-way telephone communications zones.
- 4. Preamplifiers, amplifiers and tone generators must automatically transfer to backup units, on primary failure.
- E. Primary Power shall be 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters 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.
- F. Secondary Power shall be a 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 - 1. Batteries shall be vented, wet-cell pocket, plate nickel cadmium.

2.4 MANUAL FIRE-ALARM BOXES

- A. Comply with UL 38.
- B. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation.
- C. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
- D. Station Reset: Key- or wrench-operated switch.

2.5 SYSTEM SMOKE DETECTORS

- A. General Requirements:
 - 1. Comply with UL 268, operating at 24-V dc, nominal.
 - 2. Provide photoelectric type unless noted otherwise on the drawings.
 - 3. Detectors shall be digital-addressable type, with integral addressable module, individually monitored at the FACU for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity by FACU.
 - a. Provide multiple levels of detection sensitivity.
 - 4. 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.).
 - 5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
 - 7. Color shall be white.
 - B. Combination Smoke and Heat Detectors
 - 1. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
 - 2. 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.
 - C. 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. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.
- 2.6 HEAT DETECTORS
- A. Comply with UL 521.
 - B. Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
 - C. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 - D. Color shall be white.
- 2.7 CARBON MONOXIDE DETECTORS
- A. Comply with UL 2075.
 - B. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 - C. Detectors shall be set to respond to the sensitivity limits specified in UL 2034.
 - D. Color shall be white.
- 2.8 NOTIFICATION APPLIANCES
- A. General Requirements:
 - 1. Connected to notification appliance signal circuits with screw terminals for system connections.
 - 2. Combination Devices, where indicated on the drawings, shall be factory-integrated audible and visible devices in a single-mounting assembly.
 - 3. Wall or ceiling mounted, refer to the drawings for requirements.
 - 4. Red finish.
 - B. Voice/Tone Notification Appliance:
 - 1. Comply with UL 1480.

2. Speakers for Voice Notification: Locate speakers for voice notification to provide intelligibility requirements of "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
 3. High-Range Units: Rated 2 to 15 W.
 4. Low-Range Units: Rated 1 to 2 W.
 5. Matching Transformers: Tap range matched to acoustical environment of speaker location.
- C. Visible Notification Appliances:
1. LED strobe lights comply with UL 1971, with clear polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch high letters on the lens.
 - a. Rated Light Output:
 - 1) 15/30/75/110 cd, selectable in the field.
 - b. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 - c. Flashing shall be in a temporal pattern, synchronized with other units.
 - d. Strobe Leads: Factory connected to screw terminals.
- 2.9 MAGNETIC DOOR HOLDERS
- A. Wall or floor mounted, refer to drawings for requirements. Provide with matching doorplate.
 1. Wall-mounted units shall be flush mounted.
 - B. Electromagnet, requires no more than 3 W to develop 25-lbf (111-N) holding force.
 1. 24VDC, compatible with fire alarm.
 - C. Finish shall match door hardware.
- 2.10 REMOTE ANNUNCIATOR
- A. Annunciator functions must match those of FACU for alarm, supervisory, and trouble indications. Manual switching functions must match those of FACU, including acknowledging, silencing, resetting, and testing.
 - B. Alphanumeric display and LED indicating lights must match those of FACU. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.
 - C. Annunciator shall operate on 24VDC power supplied from the fire alarm control unit.
- 2.11 ADDRESSABLE INTERFACE DEVICE
- A. Integral Addressable modules.
 - B. Provide specific module type required for the application.
 - C. Communicate states to the FACU.
 - D. Local LEDs provide indication of activity and faults.
 - E. Mounted in an approved enclosure.
- 2.12 COMMUNICATOR TRANSMITTER
- A. UDACT

1. Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and connect to the IP or Cellular Communicator.
2. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - a. Verification that both telephone lines are available.
 - b. Programming device.
 - c. LED display.
 - d. Manual test report function and manual transmission clear indication.
 - e. Communications failure with the central station or fire-alarm control unit.
3. Digital data transmission shall include the following:
 - a. Address of the alarm-initiating device.
 - b. Address of the supervisory signal.
 - c. Address of the trouble-initiating device.
 - d. Loss of ac supply or loss of power.
 - e. Low battery.
 - f. Abnormal test signal.
 - g. Communication bus failure.
4. Secondary Power: Integral rechargeable battery and automatic charger.
 - a. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.13 DEVICE GUARDS

- A. Manual Pull Stations:
 1. Provide factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.
- B. Other devices:
 1. Welded wire mesh of size and shape for the device requiring protection.
 2. Factory fabricated and furnished by manufacturer of device.
 3. Color/finish to match the protected device.
- C. Provide device guards where indicated on the drawings.

2.14 SURGE PROTECTION

- A. Acceptable Manufacturers:
 1. 120 Volt/20 Amp – Ditek 120SR
 2. Analog Dialer – Ditek 2MHTPWb
 3. IP Dialer – Ditek MRJ45C5E
 4. Exterior Fire Alarm Circuits – Ditek LVLP Series
 5. The above list of equipment represents a minimum standard of quality. It is not intended to limit the acceptable manufacturers. Equivalent surge protection devices may be provided by other manufacturers.

- B. Provide surge protection for the following:
 - 1. 120 Volt AC circuits connected to the control panel, extender panels and any other fire alarm device requiring 120 Volt connections.
 - 2. All exterior fire alarm circuits.
 - 3. IP or analog automatic dialers. Provide protection on the telephone or data cables extending to/from the dialer.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate connection of the IP Communicator to the Local Area Network with the Owner's I. T. Representative.

3.2 INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. Equipment Mounting
 - 1. Devices shall be flush mounted unless installed on an existing wall.
 - 2. FACU shall be flush mounted when located in public areas or installed on an existing wall. Otherwise it shall be surface mounted in space not visible or accessible to the public.
 - 3. Annunciator shall be flush mounted unless installed on an existing wall.
 - 4. Install FACU with top of cabinet not more than 72 inches above the finished floor.
 - 5. Install annunciator with top of panel not more than 72 inches above the finished floor.
- C. Refer to Division 26, Raceways, Boxes, Power Conductors and Cables for:
 - 1. Raceways and boxes installation requirements.
 - 2. Line voltage circuit requirements.
- D. Install seismic-restraint devices.
- E. Renovations:
 - 1. Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted:
 - a. Notify the Owner in advance of proposed interruption of fire-alarm service.
 - b. Do not proceed with interruption of fire-alarm service without Owner's permission.
 - 2. Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.
 - 3. After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.
 - 4. New equipment indicated to be connected to an existing FACU/system shall be fully compatible with the existing system.

- a. Provide all necessary components to interface the new equipment to the existing system.
- F. Remote Antenna for Cellular Communicator
 - 1. The contractor shall determine the antenna placement location that provides the best performance.
 - a. Install the antenna in a location that receives adequate signal strength.
 - 2. Antenna extender cables shall be installed within raceway.
- G. Smoke- or Heat-Detectors:
 - 1. System smoke detectors shall be installed at each remote power supply location.
 - 2. Locate detectors not closer than 5 feet from air-supply diffuser or return-air opening.
 - 3. Locate detectors not closer than 12 inches from any part of a lighting fixture.
 - 4. Duct Smoke Detectors:
 - a. Install sampling tubes so they extend the full width of duct. Connect the integral relay to the associated HVAC equipment as required to shut down the fan(s). Coordinate all work with the Mechanical contractor.
- H. Remote Booster Power Supplies: These are not shown on the contract documents. This is part of the delegated design and the location and quantities are left to the discretion of the contractor.
 - 1. The power supplies shall be installed in a readily accessible location, concealed from public view and access.
- I. 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.
- J. Connections:
 - 1. Make addressable connections with supervised interface device to the following devices and system. Install interface device less than 36 inches from device controlled. Make addressable confirmation connection when such feedback is available at device or system being controlled.
 - a. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
 - b. Alarm -initiating connection to stairwell and elevator-shaft pressurization systems.
 - c. Smoke dampers in air ducts of designated HVAC duct systems.
 - d. Magnetically held-open doors.
 - e. Electronically locked doors and access gates.
 - f. Alarm-initiating connection to elevator recall system and components.
 - g. Alarm-initiating connection to activate emergency lighting control.
 - h. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
 - i. Supervisory connections at valve supervisory switches.
 - j. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.

- k. Supervisory connections at elevator shunt-trip breaker.
 - l. Supervisory connections at fire-pump engine control panel.
 - m. Supervisory connections of the Emergency Responder Radio Coverage System.
 - 2. Provide connection from fire alarm system to each sound system headend for the purpose of muting the local sound system(s) during an active fire alarm.
 - 3. Provide Communicator connection to the network:
 - a. Refer to the Communications specifications in Division 27 for network cabling, equipment installation requirements.
- K. Identification
 - 1. Identify system components, wiring, cabling, and terminals.
 - 2. Located at FACU:
 - a. Install computer generated, framed instructions. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.
 - b. Provide circuit directory, device list, address list.
 - c. Provide service company contact details.
 - d. Provide as-builts or device location diagrams.
 - 3. Conduit and boxes containing fire alarm cables and devices shall be red.
 - 4. Label address on device.
 - 5. Provide function specific labeling for connections/interfaces to other systems.
 - 6. Label fire alarm equipment connected to line voltage power (120V) with the corresponding branch panel name and circuit number. Refer to the labeling detail on the drawings for additional information.
- L. Grounding
 - 1. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100.
- M. Software
 - 1. Comply with UL 864.
 - 2. Technical Support: Beginning with Substantial Completion, provide software support for two years.
 - 3. 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.
 - a. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.
- N. Monitoring
 - 1. The contractor is responsible for providing a U.L. Listed fire alarm monitoring service for one year after substantial completion.

3.3 FUNCTIONAL TESTING

- A. Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
 - 1. Field tests shall be witnessed by authorities having jurisdiction.
- B. Tests and Inspections:
 - 1. Inspections, testing and maintenance shall comply with the requirements in NFPA 72 and the manufacturer's instructions.
- C. Prepare test, inspection, and record of completion documentation reports.
 - 1. Include a copy in the Operation and Maintenance Manual.
- D. Maintenance Test and Inspection:
 - 1. For one year after the date of substantial completion, perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- E. Annual Test and Inspection:
 - 1. Perform annual test and inspection one year after date of Substantial Completion, use forms developed for initial tests and inspections.

3.4 OWNER TRAINING

- A. Owner training shall not occur until the system is fully operational, software programmed, and all punch list items are completed. If 3rd party commissioning is provided for the project, the owner training shall not occur until the resolution tracking form is completed.
- B. The presenter/trainer shall be a manufacturer's authorized representative.
- C. The training shall educate the Owner on how to adjust, operate, and maintain the fire alarm system.
- D. The contractor shall provide the following at a minimum for owner training:
 - 1. Sign-in sheet documenting the attendees and presenter's names and contact information.
 - a. Include the date and time the training occurred.
 - 2. A copy of the operation manual for the system shall be provided to each attendee.
 - a. The operation manual shall be reviewed with the attendees in conjunction with the physical demonstration of the system.
 - 3. Eight (8) hours total of in-service training.
 - a. The training time shall be divided into a minimum of two segments occurring on separate days.
 - 4. The training shall be digitally recorded (audio and video). A copy of the recording shall be included with the O&M manual.

END OF SECTION 28 31 11

SECTION 28 41 02 - EMERGENCY RADIO COMMUNICATIONS ENHANCEMENT SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Refer to the general requirements specification, Section 26 05 00.
- B. Section includes items pertaining to the emergency radio communication enhancement system (ERCES), including but not limited to the following:
 - 1. Bi-directional amplifiers (BDA's)
 - 2. Distributed Antenna System
 - 3. Coaxial cables
 - 4. Splitters and direction couplers
 - 5. UPS
 - 6. Testing

1.2 SCOPE

- A. The design of the ERCES is delegated to the contractor.
- B. The following shall be included in the BASE BID for the project:
 - 1. Provide initial emergency radio coverage testing in accordance with the requirements of the International Fire Code (IFC), NFPA 72, NFPA 1221, and the Authority Having Jurisdiction (AHJ).
 - a. This testing will occur near the completion of construction, at an AHJ approved phase of construction.
 - 1) At a minimum, walls, doors, roofing, structural, and any other components that could be an impediment to the transmission and reception of radio signals shall be installed prior to testing.
 - 2. Line voltage circuits, pathways, boxes, etc. as described in this specification and on the contract drawings.
- C. The following shall be included as ALTERNATE pricing for the project:
 - 1. Provide an ERCES that delivers the required emergency responder radio coverage for the facility.
 - a. The system shall meet the requirements of UL, IFC, NFPA 72, NFPA 1221, and the AHJ.
 - 2. Provide final acceptance testing after installation.
 - 3. All miscellaneous items and accessories required for a complete and operational system shall be provided whether or not each item is explicitly mentioned in these specifications or shown on the contract drawings.
 - 4. Provide a complete and operational system as described within this specification and as shown on the contract drawings.
 - 5. The contractor shall guarantee the pricing for this alternate for the duration of contract.
 - a. Equipment shall not be procured, and installation shall not occur until after the initial radio coverage testing has been completed.
 - 6. All fees associated with the licensing.

D. Seismic

1. Refer to the structural drawings and specifications for seismic design requirements.
2. Refer to the Seismic and Wind Controls for Electrical Systems specification, section 26 05 48 for additional requirements.
3. The specified work in this section must withstand the seismic hazard design loads for the installed elevation above and below grade.
 - a. The term 'withstand' means 'unit must remain in place without separation of parts from unit when subjected to specified seismic design and unit must be fully operational after seismic event'.

1.3 SUBMITTALS

A. Product Data

1. Submit at the beginning of construction.
2. Provide the manufacturer's product data sheets for each component to be utilized on this project, including but not limited to the following:
 - a. BDA's
 - b. In-building service antennas
 - c. Outdoor Donor antenna
 - d. Coaxial Cabling
 - e. Couplers and splitters
 - f. Remote indicator panels

B. Shop Drawings

1. Provide shop drawings as described below for the following:
 - a. Preliminary Design – Submit at the beginning of construction.
 - b. Final Design – Submit after initial/baseline testing.
2. Device layout with cable and conduit routing drawn on floor plan.
 - a. Include antenna numbers, coaxial cable routes, and the locations of any other system components including splitters, couplers, filters, amplifiers, etc. All components shall be named or labeled for reference in power budget calculations tables. Overlay approximated coverage radii indicating -95 dBm downlink (base to mobile) signal strength around each proposed indoor coverage antenna.
 - b. Identify each piece of equipment by brand, model number and equipment type (e.g. Acme BA123 RF amplifier).
 - c. Indicate pathways with class and survivability identification.
 - d. Include a minimum of (1) building elevation depicting the location of any outdoor antennas. Include height of the antenna centerline above building, orientation, and location of all external grounding connections.
3. Block diagrams.
4. System communications details.
5. Sequence of Operations.
6. System mounting details.

- a. Include a detail plan view of all Telecommunications Spaces housing head-end and/or other consolidated equipment, showing the location of the rack(s) and/or enclosure(s) of the ERCES.
- 7. Secondary Power (Battery) Calculations.
- 8. Installation details and instructions for the following:
 - a. Mounting and/or attachment of equipment to other trades. Example: Donor antenna attachment to building/roof.
- C. Seismic Performance Certificates
 - 1. Provide certificates for the equipment and accessories, from the manufacturer. Include the following:
 - a. Basis for Certification
 - 1) Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outlined Drawings of Equipment
 - 1) Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.

1.4 OPERATION AND MAINTENANCE MANUALS

- A. Baseline Radio Signal Strength Testing Report:
 - 1. Detailed report indicating NFPA 72 or NFPA 1221 plotted interior radio signal strength or delivered audio quality score throughout the building critical and general areas prior to the installation of the ERCES.
 - 2. Approval from the AHJ to omit the ERCES within building areas where the baseline radio signal strength values are provided within these areas.
- B. System Inspection and Testing Report:
 - 1. Detailed report of completed system acceptance testing.
- C. Provide copy of the warranty documentation.
- D. Provide contact information. The contact information shall include names, physical addresses, phone numbers and email addresses of the following:
 - 1. Installing company
 - a. Specific contact person(s) for technical assistance, service and maintenance.
 - b. Emergency contact information for after-hours technical assistance, service and maintenance.
- E. Provide a copy of the owner training sign-in sheet.
- F. Provide a digital copy of the recording from the owner training session.
- G. Provide a complete material and equipment list with corresponding part/model numbers.
- H. Provide an operation/user manual detailing operating instructions, programming instructions, maintenance requirements, testing requirements and trouble-shooting procedures.

- I. Provide software, including system restore, emergency boot diskettes, and drivers for all installed hardware.

1.5 QUALITY ASSURANCE

- A. All equipment supplied for this system shall be the product of a single manufacturer, unless specifically noted otherwise.
- B. Design and Installing Contractors:
 - 1. The contractors shall be a manufacturer's authorized representative, trained and approved for the design and installation of this system.
 - 2. The contractors shall have been in business for a minimum of 5 consecutive years prior to the date of this contract.
 - 3. The contractors shall have and maintain a full equipment service department capable of providing inspections, service and repairs for the system.
- C. All materials, unless otherwise specified, shall be new and free from any defects.
- D. The system must comply with the following:
 - 1. Applicable building codes, including but not limited to the following:
 - a. UL 2524 in-building 2-way Emergency Radio Communication Enhancement System.
 - b. NFPA – 1, 72, 1221
 - c. KBC/IBC
 - 2. Local requirements of the AHJ.

1.6 WARRANTY

- A. The manufacturer shall warranty and agree to repair or replace all components that fail due to defects in material or workmanship for a period of 5 years starting from the date of substantial completion.
 - 1. The contractor shall be responsible for repairing or replacing all components that fail within one year of the date of final acceptance of the system. The contractor will be financially responsible for the cost of material and labor for this period.
 - 2. The remainder of the warranty period shall apply to material costs only. Labor costs are excluded after the first year.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. RSI
- B. Fiplex
- C. Westell
- D. ADRF
- E. Potter
- F. Nextivity

2.2 GENERAL PERFORMANCE REQUIREMENTS

- A. The in-building ERECS shall improve wireless communication.
- B. The system shall allow radio signals to pass to and from the interior of the structure for facilitating radio communications using public emergency service radio frequencies.

- C. The signal booster shall be a class B Public Safety type as designated by the FCC or as required by the AHJ.
- D. All signal boosters and other active system components must have FCC certification prior to installation. The equipment FCC ID must be shown on the product datasheets and technical submittals. The ID must also be displayed on the products as required by the FCC.
- E. The signal booster shall be pre-set by the equipment manufacturer for the frequencies specified by the AHJ. Field tuning of RF filters and duplexers is not allowed.
- F. UHF and VHF signal boosters shall be band selective type with a maximum 3dB channel bandwidth of 200KHz ($F_c \pm 100\text{KHz}$) per band. Non-selective wide-band signal boosters shall not be accepted, unless required to cover multiple channels within the same band.
- G. Signal Boosters shall have oscillation suppression circuitry to protect the public safety radio system in case of system malfunction or other causes. The oscillation suppression circuit shall not disable the system operation. Systems that automatically disable the signal booster upon oscillation detection shall not be allowed.
- H. Signal Boosters shall have uplink noise suppression function to eliminate uplink noise while in standby (i.e. no radio transmission from within a building). Systems that produce any measurable level of uplink noise while in standby shall not be allowed.
- I. Signal Booster gain shall be rated at minimum of 80dB and the gain shall be adjustable in a minimum of 30dB range. System gain shall be set and documented at the time of the final system test.
- J. Maximum Propagation delay of the signal booster system shall be 14 μs (microseconds) or as specified by AHJ.
- K. The signal booster system shall include built-in automatic supervision of malfunctions of the signal booster and battery system as per NFPA 1221 NFPA 72 and IFC. Non-OEM equipment add-ons and modifications to comply with this specification shall not be allowed.
- L. A dedicated supervised monitoring panel shall be provided next to the fire alarm annunciator or other location as designated by AHJ to annunciate the status of all signal booster locations. The monitoring panel shall provide visual and labeled indication of the following for each signal booster:
 - 1. Normal AC power
 - 2. Signal booster trouble
 - 3. Antenna Failure
 - 4. Loss of normal AC power
 - 5. Failure of battery charger
 - 6. Low battery capacity
- M. At least two (2) independent and reliable power supplies shall be provided, one primary and one secondary. The primary power source shall be supplied from a dedicated 20 ampere branch circuit and comply with NFPA 70, 72 and 1221. The secondary power source shall be a dedicated battery, capable of operating the in-building radio system for at least 24 hours of 100% system operation. The battery system shall automatically charge in the presence of external power input. The battery system shall be contained in NEMA 4 or 4X type enclosures. Monitoring the integrity of power supplies shall be in accordance with NFPA 72.
- N. Survivability:

1. All main risers or trunks of the antenna system shall be installed with resistance to attack from a fire using one of the following methods:
 - a. A 2-hour fire rated cable or cable system.
 - b. Routing the cable through a 2-hour fire rated enclosure(s) or shaft(s).
 - c. A system configured in a looped design, routed through 1-hour fire rated enclosure(s) or shaft(s). The circuit shall be capable of transmitting and receiving a signal during a single open or non-simultaneous single ground fault on a circuit conductor.
 - d. Performance alternative approved by the authority having jurisdiction.
2. The signal booster and all associated RF filters shall be housed in a single, NEMA 4 certified, painted steel weather tight box. The cabinet shall be large enough to dissipate internal heat without venting the inside of the cabinet to the outside atmosphere. Operating temperatures: -22 degrees F to +120 degrees F (-30 degrees C to +50 degrees C) minimum temperature range, including microprocessors. Equipment installed on the roof of structures shall be rated for the expected extreme temperatures associated with rooftop installations.
3. Cable:
 - a. Cable shall be 2-hour fire rated plenum.
- O. The system shall be normally powered on and shall continuously provide passing of frequencies within the Public Safety and First Responder bands.
- P. All in-building radio systems shall be compatible with both analog and digital communications simultaneously at the time of installation.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate all testing, installations, inspections, etc. with the AHJ.

3.2 INSTALLATION

- A. Install all components of the system in accordance with the manufacturer's instructions.
- B. Cabling:
 1. Coaxial cabling may be installed open-air where located above concealed, accessible ceilings only. Otherwise, all cabling shall be installed in conduit.
 - a. Cabling installed open-air shall be supported by J-hooks in a similar manner as the communications cabling. Refer to the specification sections Communications Equipment Room 271100, Communications Backbone Cabling 271300, Communications Horizontal Cabling 271500 and the contract drawings for additional information.
 - b. Refer to specification section Raceways, Boxes, Power Conductors and Cables 260533 for conduit and box requirements.
 2. Install cables without damaging conductors, shield, or jacket.
 3. Do not bend cables, while handling or installing, to radii smaller than as recommended by manufacturer.
 4. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
 5. Coaxial antenna cabling shall not be installed in the same conduit, raceway, or cable trays used for other systems.

- C. Provide a sign located at the fire alarm panel with the name and telephone number of the local Fire Department indicating that they shall be notified of any failures that extend past the 2 hour time limit.
- D. Provide connection between the ERCES and the fire alarm system to monitor the integrity of the circuit of the signal booster(s) and power supplies and annunciate this malfunction on the fire alarm system shall comply with NFPA 72.
- E. Install monitoring panel adjacent to the fire alarm annunciator.
- F. Coordinate all roof penetrations with Owner and roofing contractor.
- G. Provide a list of contact personnel with phone numbers and locate at the radio repeater system cabinet. The contact personnel shall have knowledge of the building and the repeater system and be available to respond to the building in the case of an emergency.
- H. Grounding:
 - 1. Ground cable shields and equipment per Manufacturer's requirements.
 - a. Provide grounding blocks and surge protection for outside cabling.
 - b. Bond system to the main grounding busbar with bonding conductor.

3.3 TESTING

- A. All testing shall be done in the presence of a local fire department representative or the local fire department unit.
 - 1. Provide initial/baseline testing and final acceptance testing.
- B. All tests shall be conducted, documented, and signed by a person in possession of a current FCC General Radio telephone Operator License or equivalent as determined by the local Fire Department.
 - 1. All testing personnel shall be certified and authorized by the signal booster manufacturer in the installation and operation of their equipment.
- C. Submit final system design plans and specifications to the fire department. Obtain written/stamped approval.
 - 1. Stamped plans are required to be present at the acceptance test.
 - 2. Any field changes that occur shall be incorporated into new plans, including any manufacturer's data sheets for any equipment changes not submitted in the original submittal. Final plans, incorporating any field changes shall be submitted to the local Fire Department for approval.
 - 3. Include testing results of the repeater (output wattage, gain level, etc) and connection to the fire alarm.
- D. Testing Procedures
 - 1. All testing must be done on frequencies authorized by the FCC.
 - 2. Tests shall be made using frequencies close to the frequencies used by the Fire Department. If testing is done on the actual frequencies, then this testing must be coordinated with the local Fire Department unit. All testing must be done on frequencies authorized by the FCC. A valid FCC license will be required if testing is done on frequencies different from the police, fire or emergency medical frequencies.
 - a. Perform tests with a calibrated spectrum analyzer.

3. For testing system signal strength and quality, the testing shall be based on the delivered audio quality (DAQ) system. A DAQ level below 3.0 shall be considered a failed test for a given grid cell.
4. Measurements shall be made with the antenna held in a vertical position at 3 to 4 feet above the floor to simulate a typical portable radio worn on the belt or turnout coat pocket.
5. Tests shall be performed on a grid system. Provide plans showing each floor divided into the grids. Each grid shall be labeled to indicate the DAQ result.

3.4 MAINTENANCE AND ANNUAL TESTING

A. Maintenance Contract

1. Provide a maintenance contract with a Radio Service Provider that will provide emergency response within (1) one business day after notification. The system shall be maintained in accordance with FCC requirements. The contract shall be for 1 year from the date of final acceptance.
2. Radio Service Provider maintenance contract shall include but not limited to:
 - a. Annual Test
 - 1) All active components of the distributed antenna system, including but not limited to amplifier, power supplies, and back-up batteries, shall be tested a minimum of once every 12 months.
 - 2) Amplifiers shall be tested to insure that the gain is the same as it was upon initial installation and acceptance. The original gain shall be noted and any change in gain shall be documented.
 - 3) Back-up batteries and power supplies shall be tested under load for a period of 1 hour to verify that they will operate during an actual power outage.
 - 4) Active components shall be checked to determine that they are operating within the manufacturer's specifications for their intended purpose.
 - 5) Documentation of the test shall be maintained on site and a copy forwarded to the local Fire Department Radio Supervisor upon completion of the test.
3. Provide annual test 1 year from the date of final acceptance.

3.5 OWNER TRAINING

- A. Owner training shall not occur until the system is fully operational, software programmed, and all punch list items are completed. If 3rd party commissioning is provided for the project, the owner training shall not occur until the resolution tracking form is completed.
- B. The presenter/trainer shall be a manufacturer's authorized representative familiar with the system(s).
- C. The contractor shall provide the following at a minimum for owner training:
 1. Sign-in sheet documenting the attendees and presenter's names and contact information.
 - a. Include the date and time the training occurred.
 2. A copy of the operation manual for the system shall be provided to each attendee.

- a. The operation manual shall be reviewed with the attendees in conjunction with the physical demonstration of the system.
- 3. Eight (8) hours total of in-service training.
 - a. The training time shall be divided into a minimum of two segments occurring on separate days.
- 4. The training shall be digitally recorded (audio and video). A copy of the recording shall be included with the O&M manual.

END OF SECTION 28 41 02

SECTION 310000 **EARTHWORK**

1. GENERAL

1.1 BASIS FOR BIDS

Base bids on excavating and filling with materials encountered at site except where special fill or backfill materials are specified herein or indicated on Drawings. No allowance or extra payments will be made by reason of variation in types of soil encountered or variations in their moisture contents. Furnish additional fill material required and included as a part of the work. Include removal of excess or objectionable materials as a part of the work.

1.2 QUALITY ASSURANCE

- A. Shoring, sheeting, bracing and retention plans, details and other provisions necessary in order to safely excavate trenches for this project shall be prepared by a Professional Engineer registered in the jurisdiction where project is located and employed by Contractor.

Contractor is solely responsible for retention plans, details, accessories and execution.

Regulatory Requirements: Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.

Testing and Inspection Service: Owner will engage soil testing and inspection service for quality control testing during earthwork operations.

1.3 PROTECTION

- B. Protect trees, shrubs, lawns, rock out-croppings and other features remaining as a portion of final landscaping.

Protect benchmarks, existing structures, fences, sidewalks, paving, and curbs from equipment and vehicular traffic.

Protect above and below grade utilities which are to remain.

Protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent cave-in or loose soil from falling into excavation. Monitor shoring system and surrounding ground surface during construction to detect movement. If movement becomes significant, take contingency steps to brace excavation and adjacent utility lines.

Notify Owner's Representative of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.

Grade excavation top perimeter to prevent surface water run-off into excavation.

2. PRODUCTS

2.1 STOCKPILING

Material cut or excavated from building areas which is suitable for backfilling may be stored on site to be distributed later.

Fill material required to be hauled in may be stockpiled at site until used, provided it is properly handled to prevent contamination with undesirable materials.

Stockpile topsoil separate from excavated sub-soil.

2.2 SURPLUS MATERIALS

- A. Remove excavated materials not to be used in fills and backfills on this project from site immediately.

Remove materials containing rubbish, debris, fracture limestone, or rocks.

2.3 SOIL MATERIALS

- B. General Fill and Backfill: Suitable existing excavated on-site soil free from vegetation, debris, and other deleterious matter, unless otherwise noted.

Fill Beneath Structures: Select sandy clay, inert and non-expansive, compacted to 98% of standard proctor density.

Base Material in Parking/Drive Areas: clay, inert and non-expansive, compacted to 95% of standard proctor density.

Top Soil:

Clean natural topsoil free of vegetation, debris and other deleterious matter, and approved by Owner's Representative.

Upper 6 inches of topsoil stripped may be used, if suitable, otherwise use Imported natural, fertile, friable soil possessing characteristics representative of productive growing soils in the area.

Granular Leveling Course Under Slabs, Walks, and Decks on Grade: dense grade aggregate, free of organic matter, clays or other binder materials.

Impervious Clay Soil: Clayey material having a plasticity index in excess of 30.

3. EXECUTION

3.1 EXAMINATION

Establish extent of excavation by area and elevation; designate and identify datum elevation.

Set required lines and levels.

Maintain bench marks, monuments and other reference points.

3.2 PREPARATION

A. Existing Utilities:

Before starting excavation, establish location and extent of underground utilities occurring in work area.

Notify utility companies to remove and relocate lines which are in way of excavation.

Maintain, reroute or extend as required, existing utility lines to remain which pass through work area.

Protect utility services uncovered by excavation.

Upon discovery of unknown utility or concealed condition, discontinue affected work and notify Owner's Representative.

3.3 ROUGH GRADING

B. Excavation and rough grade to lines and grades shown.

Overcut planting and lawn areas to allow a layer of topsoil not less than 6 inches thick.

Maintain excavations to drain and be free of excess water. Ponding of water on site will not be permitted.

Remove objectionable and excess materials from site when excavated.

3.4 EXCAVATION – GENERAL

C. Excavation Classification:

Unclassified and includes excavation to subgrade elevations indicated, regardless of character of materials and obstructions encountered.

Unauthorized Excavation:

Consists of material removal beyond indicated subgrade elevations or dimensions without specific direction of Owner's Representative.

Correct unauthorized excavation, as well as remedial work directed by Owner's Representative, at no additional cost to Owner.

Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom without altering required top elevation.

Lean concrete fill may be used to bring elevations to proper position, when acceptable to Owner's Representative.

Backfill and compact other unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Owner's Representative.

Additional Excavation:

When excavation has reached required subgrade elevations, notify soils testing laboratory for examination of conditions.

If unsuitable bearing materials are encountered at required subgrade elevations, excavate deeper and replace excavated material as directed by soils testing laboratory.

Removal of unsuitable material and its replacement as directed will be paid on basis of Contract conditions relative to changes in Work.

Dewatering:

Prevent surface water and subsurface or ground water from flowing into excavations and from flooding Project site and surrounding area.

Do not allow water to accumulate in excavations.

If presence of subsurface water is encountered during excavation, provide interior drainage.

Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations.

Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas.

Do not use trench excavations as temporary drainage ditches.

3.5 STRUCTURAL EXCAVATION

- D. Locate and mark existing underground utilities and services before beginning structural excavation.

Provide excavation for structures and footings, as required for construction, bracing and removal of forms, applying waterproofing, and to permit inspection.

Machine slope banks to angle of repose or less until shored. Do not allow excavation to interfere with normal 45-degree angle bearing splay of any foundation.

Ensure bottom of excavation is reasonably level.

Maintain excavations in as near their natural moisture conditions as possible.

Fill over-excavated areas under structure bearing surfaces in accordance with Owner's Representative's direction.

Do not allow construction equipment to create "pumping" of soils.

Remove boulders or cobbles.

3.6 FILLS AND BACKFILLS – GENERAL

- E. Verify areas to be backfilled are free of debris, snow, ice or water, and ground surfaces are not frozen.

Proof roll exposed sub grade in building and paving areas with heavily loaded dump truck or similar acceptable construction equipment, to detect unsuitable soil conditions. Commence proof rolling operations after a suitable period of dry weather to avoid degrading acceptable sub grade surfaces. Make 4 passes over each section with proof rolling equipment, with the last 2 passes perpendicular to the first 2 passes.

Cut out soft areas of sub grade not readily capable of in-situ compaction. Backfill and compact to density equal to requirements for subsequent backfill material.

Site backfill systematically, as early as possible, to allow maximum time for natural settlement. Do not backfill over porous, wet or spongy sub grade surfaces.

Maintain optimum moisture content of backfill materials to attain required compaction density.

Make gradual changes in grade. Blend slopes into level areas.

3.7 FILLS WITHIN STRUCTURE

F. Select Fill Beneath Slabs on Grade:

Scarify exposed sub-grade to a depth of 6 inches and re-compact to a density and moisture content as recommended in soils investigation report.

Place Select Fill in loose lifts of 8 inches and compact each lift to a density and moisture content as recommended in soils investigation report.

Place Select Fill to a minimum depth as indicated in soils investigation report.

Prevent excessive loss of moisture during construction.

3.8 FILLS OUTSIDE STRUCTURE

G. Roughen and loosen filled areas before placing of fill materials.

Spread suitable fill materials in uniform layers over area not to exceed 8 inches thick compaction.

Wet and work materials as required for proper compaction and thoroughly mix.

Compaction: By tamping rollers or by utilizing excavation equipment to spread and compact fill to a uniform density equal to natural density of material before excavating.

Areas adjacent to building, or where compacting equipment cannot work: Compact with hand tampers.

Compact filled areas to 90 percent Standard Proctor and to lines and grades shown, with allowances for a final layer of topsoil in lawn and planter areas.

Base Material Beneath Paving: Fill beneath paving with material, placed at density and moisture content as recommended in soils investigation report.

3.9 BACKFILL OUTSIDE STRUCTURE

H. Ensure areas to be backfilled are free from debris, snow, ice and water and that ground surfaces are not in frozen condition.

Do not backfill over existing subgrade surfaces which are porous, wet or spongy.

Backfill areas to grades, contours, levels and elevations indicated.

Backfill systematically and as early as possible to allow maximum time for natural settlement and compaction.

After permanent construction is in place, forms and trash removed, sub-soil drainage and water-proofing complete and inspections complete, backfill with approved materials and compact to approximate density of natural ground.

Place backfill in layers not exceeding 8 inches loose depth, and hand or machine tamp to compaction required.

Water may be added to backfill material as an aid to compaction; however, do not allow material to become wet to form a mud or paste.

3.10 REMOVAL OF CONTAMINATED SOIL

- I. Prior to Finish Grading: Remove soil contaminated with lime from lawn and plant bed areas. Replace with clean, approved topsoil.

3.11 FINISH GRADING

- J. After completion of rough grading and site cleared of construction debris, cover areas disturbed by construction or graded to provide new finish grades with a layer of topsoil not less than 6 inches thick.

Provide final grades as shown or as directed by Owner's Representative, slope away from building, and provide drainage for area.

Degree of Finish: That ordinarily obtainable with blade grader or scraper operations.

Finish Surfaces: No greater than 0.10 feet above or below established grade elevation.

Provide uniform rounding at top and bottom of slopes and other breaks in grade. Correct irregularities and areas where water will stand.

Uniformly distribute topsoil to required grades; feather back to where grades remain unchanged.

Finish lawn and unpaved areas to 1 inch below top of walk and curbs.

3.12 FIELD QUALITY CONTROL

- K. Testing Laboratory Services:

Owner will engage soil testing and inspection service for quality control testing during soil stabilization, fill and backfill operations.

Submit soil materials proposed for fill and backfill to laboratory for testing.

Laboratory will determine suitability of materials to be used.

Laboratory will submit test results and recommendations.

Advise testing laboratory 48 hours minimum in advance of operations.

Tests will be executed immediately prior to covering of such compacted areas.

When tests indicate compaction does not meet requirements, remove fill and backfill completely, dry out or moisten as necessary and re-compact.

Retest re-compacted areas.

Repeat until test indicates compliance with specified requirements.

Provide reworking and retesting at no additional cost to Owner.

Testing laboratory will inspect soil stabilization operations. Notify laboratory when operations are to begin.

Testing laboratory will perform one field density test of each lift per 5000 square feet of compacted fill materials for building slab and paved areas.

For each strata of soil on which footings will be placed, testing laboratory will conduct at least one test to verify required design bearing capacities. Subsequent verification and approval of each footing sub-grade may be based on a visual comparison of each sub grade with related tested strata, when acceptable to Owner's Representative.

Laboratory will perform one series of tests on area being evaluated in accordance with ASTM D 2922 and D 3017, or ASTM D 1556 and D 1557.

If during progress of Work tests indicate that compacted materials do not meet specified requirements, remove defective work, replace and retest at no additional cost to Owner.

Ensure compacted fills are tested before proceeding with placement of surface materials.

3.13 ADJUSTING

- L. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

Where completed compacted areas are disturbed by subsequent construction operation or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.

Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work and eliminate evidence of restoration to greatest extent possible.

END OF SECTION 310000

SECTION 311000
SITE CLEARING

1. GENERAL

1.01 WORK INCLUDED

- A. Clear site within construction limits of plant life and grass.
- B. Remove root system of trees and shrubs.
- C. Remove surface debris.

1.02 REGULATORY REQUIREMENTS

Conform to applicable local codes and ordinances for disposal of debris.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.01 EXISTING TREES AND OTHER VEGETATION

- A. The Contractor shall not cut or injure any trees or other vegetation outside right-of-way or easement lines and outside areas to be cleared, as indicated on the Drawings, without written permission from the Engineer. The Contractor shall be responsible for all damage done outside these lines.
- B. The Engineer shall designate which trees are to be removed within permanent and temporary easement lines or right-of-way lines.

3.02 CLEARING

- A. From areas to be cleared, the Contractor shall cut or otherwise remove all trees, brush, and other vegetable matter such as snags, bark and refuse. The ground shall be cleared to the width of the permanent easement or right-of-way unless otherwise directed by the Engineer.
- B. Except where clearing is done by uprooting with machinery, trees, stumps, and stubs to be cleared shall be cut as close to the ground surface as practicable, but no more than 6 inches above the ground surface for small trees and 12 inches for larger trees.
- C. Elm bark shall be either buried at least 1 foot deep or burned in suitable incinerators off site with satisfactory antipollution controls and fire prevention controls, to prevent the spread of Dutch Elm disease and as required by applicable laws.

3.03 GRUBBING

From areas to be grubbed, the Contractor shall remove completely all stumps, remove to a depth of 12 inches all roots larger than 3-inch diameter, and remove to a depth of 6 inches all roots larger than ½-inch diameter. Such depths shall be measured from the existing ground surface or the proposed finished grade, whichever is lower.

3.04 STRIPPING OF TOPSOIL

Prior to starting general excavation, strip topsoil to a depth of 6 inches or to depths required by the Engineer. Do not strip topsoil in a muddy condition and avoid mixture of subsoil. Stockpile the stripped topsoil within easement or right-of-way lines for use in finish grading and site restoration. Topsoil stockpiled shall be free from trash, brush, stones over 2 inches in diameter and other extraneous material.

3.05 PROTECTION

- A. Protect plant growth and features remaining as final landscaping.
- B. Protect bench marks and existing work from damage or displacement.
- C. Maintain designated site access for vehicle and pedestrian traffic.

3.06 REMOVAL

- A. All material resulting from clearing and grubbing and not scheduled for reuse shall become the property of the Contractor and shall be suitably disposed of off-site, unless otherwise directed by the Engineer, in accordance with all applicable laws, ordinances, rules and regulations.
- B. Such disposal shall be performed as soon as possible after removal of the material and shall not be left until the final period of cleaning up.

END OF SECTION 311000

SECTION 312200 **GRADING**

PART 1 GENERAL

RELATED SECTIONS

1. Section 310000 - Earthwork
2. Section 311000 – Site Clearing
3. Section 312316.26 - Rock Removal
4. Section 312323 – Soil Compaction Control

REFERENCES

1. American Society for Testing and Materials (ASTM)
 - a. ASTM D698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (600kN-m/m³).

EXISTING CONDITIONS

1. Examine subsurface investigation report which is available for inspection from Owner's Representative.
2. Known underground and surface utility lines and buried objects are as indicated on site plan.
3. Refer to dewatering in Section 31 23 33.01 - Excavating Trenching and Backfilling.

PROTECTION

1. Protect and/or transplant existing fencing trees, landscaping, natural features, bench marks, buildings, pavement, surface or underground utility lines which are to remain as directed by Owner's Representative. If damaged, restore to original or better condition unless directed otherwise.
2. Maintain access roads to prevent accumulation of construction related debris on roads.

PART 2 PRODUCTS

MATERIALS

1. Fill material: Type 3 in accordance with of Section 31 23 33.01 - Excavating, Trenching and Backfilling.
2. Excavated or graded material existing on site may be suitable to use as fill for
3. grading work if approved by Owner's Representative.

PART 3 EXECUTION

STRIPPING OF TOPSOIL

1. Do not handle topsoil while in wet or frozen condition or in any manner in which soil structure is adversely affected as determined by Owner's Representative.
2. Commence topsoil stripping of areas as indicated after area has been cleared of brush, weeds and grasses and removed from site.
3. Strip topsoil to depths as indicated. Avoid mixing topsoil with subsoil.
4. Stockpile in locations as directed by Owner's Representative. Stockpile height not to exceed 2 m.

5. Dispose of unused topsoil as directed by Owner's Representative.

GRADING

1. Rough grade to levels, profiles, and contours allowing for surface treatment as indicated.
2. Rough grade to following depths below finish grades:
 - A. 250mm for concrete slabs and walks precast paving units.
3. Slope rough grade away from building 1:50 minimum.
4. Grade ditches to depth as indicated.
5. Prior to placing fill over existing ground, scarify surface to depth of 150 mm. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.
6. Compact filled and disturbed areas to corrected maximum dry density to ASTM D698, as follows:
 - A. 85% under landscaped areas.
 - B. 95% under paved and walk areas.
7. Do not disturb soil within branch spread of trees or shrubs to remain.

TESTING

1. Inspection and testing of soil compaction will be carried out by testing laboratory designated by Owner's Representative. Refer to Sections 01 29 83 - Payment Procedures for Testing Laboratory Services and 01 45 00 – Quality Control.
2. Submit testing procedure, frequency of tests, to Owner's Representative for approval.

SURPLUS MATERIAL

1. Remove surplus material and material unsuitable for fill, grading or landscaping as directed by Owner's Representative.

END OF SECTION 312200

SECTION 312316
EXCAVATING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes temporary excavation support and protection systems.

1.2 PERFORMANCE REQUIREMENTS

1. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.

SCHEDULE 1 - Prevent surface water from entering excavations by grading, dikes, or other means.

SCHEDULE 2 - Install excavation support and protection systems without damaging existing buildings, pavements, and other improvements adjacent to excavation.

1.3 SUBMITTALS

- A. Qualification Data: For Installer and professional engineer.

1.4 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
 2. The geotechnical report is referenced elsewhere in the Project Manual.
- C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that are either new or in serviceable condition.
- B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.
- C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.
- D. Wood Lagging: Lumber, mixed hardwood.
- E. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
- F. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
 - 1. Shore, support, and protect utilities encountered.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces is not impeded.
- D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
- E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 SOLDIER BEAMS AND LAGGING

- A. Install steel soldier beams before starting excavation. Space soldier beams at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align

exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

- B. Install wood lagging within flanges of soldier beams as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.
- C. Install wales horizontally at centers indicated and secure to soldier beams.

3.3 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

- A. Tiebacks: Drill for, install, grout, and tension tiebacks into position. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.
 - 1. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.
 - 2. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 BRACING

- A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
 - 1. Do not place bracing where it will be cast into or included in permanent concrete work, unless otherwise approved by Architect.
 - 2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
 - 3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
 - 1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.

- . Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION 312316

SECTION 312316.26
ROCK REMOVAL

1. GENERAL

1.01 WORK INCLUDED

- A. The Contractor shall excavate rock, if encountered, as required to perform the required work, and shall dispose of the excavated material, and shall furnish acceptable material for backfill in place of the excavated rock.
- B. In general, rock in pipe trenches shall be excavated so as to be not less than 6 inches from the pipe after it has been laid.

1.02 REFERENCES

- A. NFPA 495 – Code for the Manufacture, Transportation, Storage and use of Explosive Materials.
- B. Commonwealth of Kentucky Department of Mines and Minerals, Laws and Regulations Governing Explosives and Blasting.

1.03 REGULATORY REQUIREMENTS

- A. Conform to Kentucky Department of Mines and Minerals code for explosive disintegration of rock.
- B. Obtain permits from local authorities having jurisdiction before explosives are brought to site or drilling is started.

2. PRODUCTS

2.01 MATERIALS

- A. Rock definition: Solid mineral material that cannot be removed with a power shovel.
- B. Explosives: Type recommended by explosives firm and required by authorities having jurisdiction.
- C. Delay devices: Type recommended by explosives firm and conforming to state regulations.
- D. Blasting mat materials: Type recommended by explosives firm and conforming to state regulations.

3. EXECUTION

3.01 EXPLOSIVES

- A. The Contractor shall keep explosives on the site only in such quantity as may be needed for the Work under way and only during such time as they are being used. He shall notify the Engineer, in advance, of his intention to store and use explosives. Explosives shall be stored in a secure manner and separate from all tools. Caps or detonators shall be safely stored at a point over 100 feet distance from the explosives. When the need for explosives has ended, all such materials remaining on the Work shall be promptly removed from the premises.
- B. The Contractor shall observe all state, federal and municipal laws, ordinances and regulations relating to the transportation, storage, handling and use of explosives. In the event that any of the above-mentioned laws, ordinances or regulations require a licensed blaster to perform or supervise the Work of blasting, said licensed blaster shall, at all times have his license on the Work shall permit examination thereof by the Engineer or other officials having jurisdiction.

3.02 BLASTING PRECAUTIONS

- A. No explosives shall be used within 20 feet of:
 - 1. Building and/or structures existing, constructed or under construction.
 - 2. Underground and/or overhead utilities whether existing or partially constructed.
- B. Permission for any deviation from the restriction set forth above shall be secured from the Engineer, in writing; however, permission for any such deviations shall not relieve the Contractor from any responsibility in the event of damage to buildings, structures or utilities.
- C. All operations involving explosives shall be conducted with all possible care to avoid injury to persons and property. Blasting shall be done only with such quantities and strengths of explosives and in such a manner as will break the rock approximately to the intended lines and grades and yet will leave the rock not to be excavated in an unshattered condition. Care shall be taken to avoid excessive cracking of the rock upon or against which any structure will be built, and to prevent injury to existing pipes or other structures and property above or below ground. Rock shall be well covered with logs or mats, or both, where required. Sufficient warning shall be given to all persons in the vicinity of the Work before a charge is exploded.

- D. The Contractor shall be solely responsible for his blasting operations. The Contractor shall not hold the Owner and/or the Engineer liable for any damages resulting from his blasting operations on this project.

3.03 PAYMENT

Rock excavation shall be bid as unclassified and will not be paid for separately.

END OF SECTION 312316.26

SECTION 312323
SOIL COMPACTION CONTROL

1. GENERAL

- 1.01** Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division One Specification sections, apply to work of this section.
- 1.02** DESCRIPTION: The work of this Section includes all field and laboratory testing of fill earth materials compaction to required densities, as required for proper placement of fill.
- 1.03 RELATED WORKS SPECIFIED ELSEWHERE**
- A. Site Clearing
- 1.04 Testing Agency:**
1. In-place soil compaction tests are to be performed by Soil Engineer.
2. Soil testing shall be paid for by the Contractor.
- 1.05 Reference Standards:**
1. American Society for Testing Materials (ASTM).
a. ASTM D 698, Standard Proctor Compaction
2. American Association of State Highway & Transportation Officials (AASHTO).
a. Designation M145, Soil Classification Groups.
- 1.06** Testing laboratory reports stating that materials for controlled fill meet requirements of this Section.
- 1.07** Provide Engineer with one (1) copy of test reports. Provide General Contractor with two (2) copies of test reports.
- 1.08** Accomplish testing in accordance with ASTM requirements relative to environmental conditions.

2. PRODUCTS

- 2.01 MATERIALS:** Soil meeting the approval of the Engineer from on site sources.

3. EXECUTION

3.01 COMPACTION

- A. Control soil compaction during construction to provide the Standard Proctor Compaction specified for each area as determined according to ASTM D 698.
- B. Provide not less than the following Standard Proctor Compaction of soil material compacted at moisture content for the actual density of each layer of soil material in place, as required by these specifications, and as approved by the Soils Engineer.

- 1. Structures:
 - a. Compact the top 8" of subgrade and each layer of fill material or backfill material to 98%.
- 2. Walks:
 - b. Compact the top 8" of subgrade and each layer of fill material or backfill material to 98%.
- 3. Pavements:
 - c. Compact the top 8" of subgrade and each layer of fill material or backfill material to 95%.

3.02 CONTROL TESTING: Provide one optimum moisture, maximum density curve for each type of soil encountered for use as fill material in accordance with ASTM D 698.

3.03 IN-PLACE TESTING: Test in place, compacted soils for each layer prior to placing the succeeding layer in accordance with ASTM D698.

3.04 MINIMUM NUMBER OF TESTS PER LAYER OF FILL: As recommended by the Engineer and as specified in Section: Site Grading.

END OF SECTION 312323

SECTION 312323.16
CRUSHED LIMESTONE COMPACTION CONTROL

1. GENERAL

- 1.01** Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division One Specification sections, apply to work of this section.
- 1.02** DESCRIPTION: The work of this Section includes all necessary labor, materials and equipment required to properly control the compaction of backfill materials as detailed on the Drawings and outlined herein.
- 1.03 RELATED WORKS SPECIFIED ELSEWHERE**
- A. Site Clearing
 - B. Excavating, Backfilling & Compacting for Utilities
- 1.04 Testing Agency:**
- 1. Geotechnical engineering firm approved by project engineer.
 - 2. Tests on material for controlled fill shall be paid by Contractor.
- 1.05 Reference Standards:**
- 1. American Society for Testing Materials (ASTM).
 - a. ASTM D 698, Standard Proctor Compaction
- 1.06** Testing laboratory reports stating that materials for controlled fill meet requirements of this Section.
- 1.07** Provide Architect with one (1) copy of test reports. Provide General Contractor with two (2) copies of test reports.
- 1.08** Accomplish testing in accordance with ASTM requirements relative to environmental conditions.

2. MATERIALS

2.01 CRUSHED LIMESTONE

- A. Standard Proctor – ASTM D 698.
- B. Minimum densities: As recommended by the Architect/Soils Engineer.
- C. Optimum moisture content: As recommended by the Architect/Soils Engineer.

3. EXECUTION

- 3.01** Inspect surfaces to receive fill for defects which may affect execution of work such as deleterious material or soft, boggy spots.
- 3.02** Do not commence compaction of fill materials until all defects are corrected.
- 3.03** Compact materials uniformly and evenly to required subgrade elevations.
- 3.04 Equipment:**
 - A. Vibratory roller or pneumatic tampers as recommended by Architect/Soils Engineer.
 - B. Sandy materials: Pneumatic wheel rollers, or as recommended by Architect/Soils Engineer.

END OF SECTION 312323.16

SECTION 312323.19
GRANULAR FILL

1. GENERAL

1.01 Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division One Specification sections, apply to work of this section.

1.02 DESCRIPTION: The work of this Section includes all labor, materials and equipment necessary to place and compact granular fill for applications as follows:

1.02.A.1 Interior concrete floor slabs on-grade.

1.02.A.2 Exterior concrete sidewalks.

1.02.A.3 Granular fill for asphalt concrete is with asphalt concrete section.

1.03 RELATED WORKS SPECIFIED ELSEWHERE

- A. Site Clearing
- B. Soil Compaction Control
- C. Bituminous Pavement
- D. Crushed Limestone Compaction Control

1.04 EXCLUSION: The work of this Section is not a part of any bituminous concrete paving which may be detailed on the Drawings and outlined herein.

- 1. Geotechnical engineering firm approved by project engineer.
- 2. Tests on material for controlled fill shall be paid by Contractor.

1.05 QUALITY ASSURANCE: Standard of the Kentucky Dept. of Highways

- 1. American Society for Testing Materials (ASTM).
 - a. ASTM D 698, Standard Proctor Compaction

2. MATERIALS

2.01 Material shall be crushed limestone. Limestone shall be from local quarry meeting the requirements of the Kentucky Department of Highways.

Granular fill under slabs and sidewalks is to be crushed limestone graded in accordance with ANSI/ASTM C 136 within the following limits:

<u>Sieve Size</u>	<u>Percent Passing</u>
2 inches	100
1 inch	95
3/4 inch	95 – 100
5/8 inch	75 – 100
3/8 inch	55 – 85
No. 4	35 – 60
No. 16	15 – 35
No. 40	10 – 25
No. 200	5 – 10

3. EXECUTION

- 3.01** Inspect subgrade to receive granular sub-base for defects.
- 3.02** Do not apply sub-base materials until all defects are corrected.
- 3.03** Apply and compact sub-base true-to-line and contour.
- 3.04** Compact granular fill with vibratory plate and/or roller to densities as recommended by the Soils Engineer but no less than 98% Standard Proctor.
- 3.05** Apply pugmill mixed material in accordance with the Kentucky Department of Highways standard specifications.

END OF SECTION 312323.19

SECTION 315000
EROSION CONTROL

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Erosion control.
2. Sediment control.

1.2 SUBMITTALS:

A. None.

PART 2 - PRODUCTS

2.1 ALL PRODUCTS:

A. Conform to details indicated in Construction Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Erosion prevention and sediment control (EPSC) measures shall be installed per notes and/or details shown on plans prior to any site construction activity. Installation materials and methods shall conform to the City of Bowling Green standards.

END OF SECTION 315000

SECTION 321216
BITUMINOUS PAVEMENT

1. GENERAL

1.01 SUMMARY

A. Provide bituminous pavement for following applications, with prepared subbase and compacted base.

1. Roads.
2. Parking areas.
3. Driveways.

B. Provide striping for parking, roadways, and handicapped markings.

1.02 SUBMITTALS

Submit for approval product data, test reports.

1.03 QUALITY ASSURANCE

Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

2. PRODUCTS

2.01 MATERIALS

- A. Prime coat: Cut-back asphalt.
- B. Tack coat: Emulsified asphalt.
- C. Asphaltic cement: AASHTO M226 and as required by local authorities.
- D. Aggregate: Crushed stone or crushed gravel.
- E. Traffic paint: Quick-drying chlorinate-rubber alkyd type, color as approved.
- F. Wheel-stops: Precast concrete of uniform color and texture with steel stakes.

3. EXECUTION

3.01 TRENCH WIDTH PAVEMENT REPLACEMENT

- A. Sections of pavement shall be replaced as required to install the pipelines. Disturbed pavement shall be reconstructed to original lines and grades with bituminous binder as detailed on the Drawings and in such manner as to leave all such surfaces in fully as good condition than that which prior to these operations.
- B. Prior to trenching, the pavement shall be scored or cut to straight edges along each side of the proposed trench to avoid unnecessary damage to the remainder of the paving. Edges of the existing pavement shall be recut and trimmed as necessary to square, straight edges after the pipe has been installed and prior to placement of the binder course or concrete.
- C. Backfilling of trenches shall be in accordance with the applicable portions of Section 02221.
- D. Bituminous base shall be one course construction of an appropriate base JMF prepared and installed in accordance with the requirements of the Kentucky Departments of Highways.
 - 1. Placement and compaction of binder course shall be in accordance with the Kentucky Department of Highways Standard Specifications. Minimum thickness after compaction shall be as detailed on the Drawings.
- E. Concrete base, as detailed on the Drawings, shall be 4,000 psi conforming to the applicable requirements of Division 3.
- F. Bituminous pavement replacement is a separate pay item.

END OF SECTION 321216

SECTION 321313
REINFORCED CONCRETE PAVEMENT

GENERAL

1.01 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301.
- B. Obtain materials from same source throughout.

1.02 REGULATORY REQUIREMENTS

- A. Conform to applicable code for paving work on public property.

1.03 TESTS

- A. Testing firm will take cylinders and perform slump and air entrainment tests in accordance with ACI 301.
- B. Four concrete test cylinders will be taken for every 50 or less cubic yards of each class of concrete placed each day.
- C. One slump test will be taken for each set of test cylinders taken.

1.04 ENVIRONMENTAL REQUIREMENTS

- A. Do not place pavement when base surface or ambient temperature is less than 40 Degrees F, or if base surface is wet or frozen.

2. **PRODUCTS**

2.01 CONCRETE MATERIALS

- A. Cement: ASTM C 150, Air Entraining-Type IA, Portland Cement, gray color.
- B. Fine and Coarse Aggregates: ASTM C 33.
- C. Water: Clean and not detrimental to concrete.

2.02 FORM MATERIALS

- A. Conform to ACI 301. If using metal, use material free of deformities. If using wood, use construction grade lumber, sound and free of warp, minimum 2-inch nominal thickness, except where short radii of curves require thinner forms.
- B. Contraction Joint Devices: Galvanized sheet metal, keyed profile, with knock-outs for reinforcing and dowel steel.

2.03 REINFORCEMENT

- A. Reinforcing Steel: ASTM A 615; 60 ksi yield grade; deformed billet steel bars, uncoated finish.
- B. Welded Steel Wire Fabric: Plain type, ANSI/ASTM A 185; in flat sheets; uncoated finish.
- C. Tie Wire: Annealed steel, minimum 16 gage size.
- D. Dowels: ASTM A 615; 40 ksi yield grade, plain steel, uncoated finish.
- E. Miscellaneous Reinforcing Accessories: Spacers, chairs, ties, and other devices necessary for properly placing, spacing, supporting, and fastening reinforcement in place.

2.04 ACCESSORIES

- A. Form Release Agent: Non-staining, paraffin-based oil.

2.05 JOINT FILLERS

- A. Wood: Construction grade, preservative treated yellow pine, sound and free of checks, splits or other defects, 3/4 inch thick.
- B. Sealants: Two or three part polyurethane sealants, of grade as required to suit application, meeting ASTM C 920, in manufacturer's custom colors.

2.06 ADMIXTURES

- A. Acceptable Manufacturers: Subject to compliance with requirements indicated, provide products of one of the following:
 - 1. W. R. Grace & Co.
 - 2. Euclid Chemical Company.
 - 3. Sika Corporation.
 - 4. Master Builders, Inc.
- B. Air Entrainment: ASTM C 260.
- C. Chemical Admixture: ASTM C 494, Type A - cement dispersing and water reducing. Use Type D - water reducing and retarding, or Type E - water reducing and accelerating as determined by climatic conditions and as approved by testing laboratory.

2.07 CONCRETE MIX

- A. Mix and deliver concrete in accordance with ASTM C 94, Alternate 2.
- B. Use accelerating admixtures in cold weather only when approved by testing laboratory. Use of admixtures will not relax cold weather placement requirements.

- C. Use set-retarding admixtures during hot weather only when approved by testing laboratory.
- D. Add air entraining agent to concrete mix for concrete work exposed to exterior, in amounts of 4 to 7 percent of total concrete volume or as otherwise recommended by testing laboratory.
- E. Maintain water-cement ratio to produce a minimum of 3 to maximum of 5-inch slump.
- F. Use of calcium chloride and fly ash are strictly prohibited.

3. EXECUTION

3.01 INSPECTION

- A. Verify compacted subgrade or stabilized soil is ready to support paving and imposed loads, free of frost, smooth and properly compacted.
- B. Verify gradients and elevations of base are correct, and proper drainage has been provided so that water does not stand in the area to receive paving.

3.02 FORMING

- A. Construct and remove forms in accordance with ACI 347.
- B. Place and secure forms to correct location, dimension, and profile. Adequately brace to withstand loads applied during concrete placement.
- C. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- D. Place joint fillers vertical in position, in straight lines. Secure to formwork during Concrete placement.

3.03 INSERTS AND ACCESSORIES

- A. Make provisions for installation of inserts, accessories, anchors, and sleeves.

3.04 REINFORCEMENT

- A. Accurately place reinforcement in middle of slabs-on-grade.
- B. Interrupt every other bar of reinforcement at control and expansion joints.
- C. Place reinforcement to achieve slab and curb alignment as detailed.

- D. Steel: Free of rust, mill scale, dirt and oil.
- E. Provide doweled joints at interruptions of concrete with one end of dowel set in capped sleeve to allow longitudinal movement. Provide support at both ends of dowels.
- F. Support reinforcing on bar chairs. Securely saddle tie at intersections. Rigidly secure in place to minimize displacement during concrete pour.

3.05 JOINTS

- A. Intentional stoppage of concrete placing allowed only at planned location of either an expansion joint or contraction joint.
- B. When stoppage occurs at an expansion joint, install joint assembly with a bulkhead of sufficient section drilled to accommodate required dowels. Provide expansion joints at maximum 40'-0" on center each way in parking lots, 40'-0" on center for curbs and maximum 20'-0" on center each way at pedestrian paving.
- C. When stoppage occurs at a contraction joint, install sheet metal joint assembly of sufficient section to prevent deflection, shaped to concrete section. Drill bulkhead to permit continuation of longitudinal reinforcing steel through construction joint.
- D. Stoppage at Unintentional Location
 - 1. Immediately upon unintended stoppage of concrete placing, place available concrete to a line and install bulkhead perpendicular to surface of pavement and at required elevation. Place and finish concrete to this bulkhead. Remove and dispose of concrete remaining on subgrade ahead of bulkhead.
 - 2. When placing of concrete is resumed before concrete has set to extent that concrete will stand on removal of bulkhead, rod new concrete with the first; otherwise, carefully preserve joint face.
 - 3. Provide a joint seal space at edges created by a construction joint of this type, as detailed on Drawings.
- E. Provide sawed contraction joints in vehicular paving and curbs spaced as detailed on Drawings, but in no case greater than 20 foot on center spacing.
 - 1. Saw joints after completion of finishing operations as soon as concrete has hardened to extent necessary to prevent revealing of joint or damage to adjacent concrete surfaces.
 - 2. Saw joints same day that concrete is placed except that sawing of joints in concrete placed late in day may be delayed until morning of following day.
 - 3. In any event, saw joints within 18 hours after placing concrete.
 - 4. Use a power-driven concrete saw made especially for sawing concrete and maintain in good operating condition.

5. Saw Blades: Make a clean, smooth cut, producing a groove 1/8 inch to 3/16-inch-wide and a depth equal to 1/4 of slab thickness, minimum 1-inch depth.
 6. Align joints in vehicular paving with joints in adjacent pedestrian paving.
 7. Cut joints through curbs at right angles to back of curb.
- F. Place joint filler between paving components and building or other appurtenances. Recess top of filler 1 inch for backing rod and sealant placement. Install sealant over backing rod in accordance with manufacturer's recommendations.
- G. Provide 3/4-inch-deep scored joints in sidewalks and plazas at intervals as indicated, but in no case spaced greater than width of walk.

3.06 PLACING CONCRETE

- A. Hot Weather Placement: ACI 305. Cold Weather Placement: ACI 306.
- B. Ensure reinforcement, inserts, embedded parts, and formed joints are not disturbed during concrete placement.
- C. Place concrete continuously between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

3.07 FINISHING AND CURING

- A. After consolidating and screeding, float concrete to gradients indicated. Use a straight edge to level and test surface in longitudinal direction to required grade. Finish edges to provide a smooth dense surface with 1/8-inch radius.
- B. Immediately after placement, protect concrete from premature drying, excessive hot or cold temperatures, and mechanical injury.
- C. Place curing compound on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.
- D. Finishes:
1. Vehicular Paving: Heavy broom.
 2. Sidewalk Paving: Light broom, radiused and trowel joint edges.
 3. Curbs and Gutters: Light broom.
 4. Inclined Pedestrian Ramps: Broom perpendicular to slope.

3.08 FIELD QUALITY CONTROL

- A. Field inspection and testing performed under provisions of Section 03300.

- 3.09 SCHEDULES (unless noted otherwise recommended by soils investigation report or if otherwise indicated on civil drawings, provide the following minimum strengths and thicknesses)
- A. Concrete Sidewalks: 3,500 psi 28-day concrete compression strength, 4 inches thick, 3 inch minimum and 5-inch maximum slump. Air content shall be 5% +/-1%.
 - B. Curbs: 3,500 psi 28-day concrete compressive strength, 3 inch minimum and 5-inch maximum slump. Air content shall be 5% +/- 1%.
 - C. Heavy Duty Pavement and Dumpster Pads: 4,000 psi 28-day concrete compressive strength, 6 inches thick, 3 inch minimum and 5-inch maximum slump.
Air content shall be 5% +/- 1%.

END OF SECTION 321313

SECTION 321823
RUNNING TRACK SURFACE

1. GENERAL

1.1 SUMMARY

- A. Section Includes: A rubber granular mat system with polyurethane binders over concrete or asphalt.
- B. Related Sections:
 - 1. 321216 – Bituminous Pavement.
 - 2. 321313 – Reinforced Concrete Pavement.

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM), latest edition:
 - 1. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
 - 2. E501 - Standard Specification for Standard Rib Tire for Pavement Skid-Resistance Tests.

1.3 SUBMITTALS

- A. Shop Drawings: Asphalt concrete and subgrade requirements.
- B. Product Data: Manufacturers specifications and printed installation and maintenance instructions.
- C. Samples: One 4 inch by 4 inch sample of track surface with samples of available colors (except black) for selection.
- D. Certification that materials delivered to site comply with specifications, and are approved by the manufacturer for use as a track binder.

1.4 QUALITY ASSURANCE

- A. United States Tennis Courts and Track Builders Association (USTC&TBA) guidelines.
- B. Pre-installation Conference: Track surface manufacturer's representative shall give written or pictorial documents indicating installation requirements.
- C. Coordinate with equipment installer the location and type of attachments required to install equipment.
- D. Manufacturer's Representative: The manufacturer of the track surface system shall provide a technical representative that does not represent the track builder, to participate in the acceptance of the asphalt concrete base before the application of the track surface and to observe the installation work. The approval of a particular manufacturer's system shall be contingent on this requirement being met.

E. Track Surface Contractors/Installers.

1. The installer must show proof of having installed a minimum of 25, paved in place, polyurethane base mat surface track systems over the last 5 years.
2. The installer shall provide test results for the polyurethane surface running track systems, from an independent testing laboratory, showing compliance with the ASTM specifications listed.
3. The installing company shall provide proof of being in business under the same name for the past 5 years.
4. The installer shall provide proof of being a member in good standing of the USTC & TBA under the same name for a period of 5 years.
5. The installer must have a Certified Track Builder (CTB) on staff as a full time employee of the company and must provide proof of certification.
6. The installer shall provide documentation of having a minimum "A" rating as established by their bonding company.
7. Show proof that installer's Base Mat (polyurethane binder/rubber) Structural Spray (Polyurethane/EPDM Rubber) System, as specified, meets the requirements of the IAAF Suitability Test for Synthetic Surfaced Athletic Tracks. Proof shall consist of test results from an independent testing laboratory indicating that the system submitted by the installer has passed all parts of the test.
8. The installer's CTB shall be on site at the beginning of the installation of the asphaltic pavement, for the running track, for a period of two days.

1.5 WARRANTY

- A. Manufacturer's minimum 5 year written warranty of track surface to be free from defects in materials and installation.

2. PRODUCTS

2.1 MANUFACTURERS

A. Track Surface:

1. Plexitrac by California Products, Cambridge, MA.
2. Fast Track by Child Safe Products, Amityville, NY.
3. Safe Guard by Safe Guard Surfacing, St.James, NY.
4. Eurotan WS by Southwest Recreational Industries, Leander, TX.
5. Synthetic Track Surface by Epiq Tracks.
6. Equivalents Approved by Owner

2.2 MATERIALS

A. Track Surface:

1. Surfacing shall be 1 to 3mm rubber granules, free of dust and extraneous fiber, metal, and similar substances, and meeting the following gradation:

<u>Mesh</u>	<u>M.M.</u>	<u>Percent Retained</u>
5	4.00	0.0
6	3.36	3.0
10	2.00	50.0
18	1.00	97.0

- a. Other sieve sizes may be used to achieve a different surface texture at the discretion of the owner.
- b. Rubber supply can vary.
- c. Comply with USTC & TBA guidelines for measuring track surface depth.
- d. Void Volume: 27 percent maximum.
- e. Baselayer: 1/2" minimum thickness, recycled or black styrene-butadiene rubber (SBR) rubber granules with polyurethane binder.
- f. Structural Spray/UV Protection: Sprayed pigmented urethane with matching color EPDM rubber granules. Color, red or green, as specified by A/E.
- g. Provide water permeable composition.

3. EXECUTION

3.1 INSPECTION

- A. Do not proceed with the work of this section until conditions detrimental to the proper and timely completion of the work have been corrected in an acceptable manner.
- B. Asphalt Concrete Base:
 - 1. Track surface shall be installed over an asphalt concrete pavement complying with M-DCPS Master Specifications Sections 02545.
 - 2. Before application of track surface, asphalt concrete base shall be inspected for conformity to slopes as indicated on construction drawings.
 - 3. The surface shall not deviate more than 1/4" in 10 feet when checked with a straight edge in all directions.
 - 4. The asphalt concrete base shall be allowed to cure for at least 2 weeks before the track surface is applied.
- C. Perform tensile and thickness testing before lane marking.

3.2 ENVIRONMENTAL CONDITIONS

- A. Temperature: A minimum of 50 degrees F. and rising.
- B. Weather: Clear with no precipitation during application.

3.3 INSTALLATION

- A. Apply track surface material over asphalt concrete following the manufacturer's printed installation instructions and M-DCPS Design Standards.
- B. After track surface has cured, layout 2-inch wide white lane markings as indicated on Construction Documents. Using rollers and appropriate templates, apply 2 coats of specified paint without splatters or irregularities.
- C. Place topsoil and sod to required finish grade elevations.

3.4 CLEANING

- A. Upon completion of the work remove all containers, surplus materials, and debris and dispose off site.

- B. Remove surplus materials from site. Remove soil, mud, and other foreign matter from track surface.
- C. Clean spills and overruns.
- D. Leave site in a clean and orderly condition acceptable to the Board.

3.5 PROTECTION

- A. Protect track surface from damage until substantial completion, especially from petroleum-based products.
- B. Provide a 10 foot wide removable protective mat to be used by maintenance vehicles for crossing the track to the infield without damaging the track surface.
- C. Provide a list of herbicides to suppress weed growth adjacent to the track without damaging the track surface.

3.6 FIELD QUALITY CONTROL

- A. Site Tests:
 - 1. The track installer shall provide a minimum of 30 test samples in the course of laying down the track surface.
 - 2. Each sample shall be 10 inches square, laid on a 1/2" plywood base adjacent to the track at roughly equal intervals around the perimeter of the track.
- B. Inspection:
 - 1. The track installer shall perform at least one evaluation of the track each year with a representative of the Board to determine the need for preventive maintenance action within the warranty requirements.

END OF SECTION

SECTION 32 31 13
COATED CHAIN LINK FENCE AND GATES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. DIVISION 01 - GENERAL REQUIREMENTS: Drawings, quality, product and performance requirements, general and supplemental conditions apply as applicable to the project and project documents.

1.2 SUMMARY

- A. This Section includes industrial/commercial chain link fence and gates specifications:
 - 1. Polymer coated steel chain link fabric
 - 2. Polymer coated galvanized steel framework and fittings
 - 3. Gates: swing
 - 4. Installation
- B. Related Sections:
 - 1. 01 33 23 Shop Drawings, product data
 - 2. 01 43 13 Manufacturers Qualifications
 - 3. 03 30 53 Miscellaneous Cast in Place Concrete
 - 4. 31 22 19 Finish Grading

1.3 REFERENCES

- A. ASTM F552 Standard Terminology Relating to Chain Link Fencing
- B. ASTM F567 Standard Practice for Installation of Chain Link Fence
- C. ASTM F626 Specification for Fence Fittings
- D. ASTM F668 Specification for Polymer Coated Chain Link Fence Fabric
- E. ASTM F900 Specification for Industrial and Commercial Swing Gates
- F. ASTM F934 Specification for Standard Colors for Polymer-Coated Chain Link
- G. ASTM F1043 Specification for Strength and Protective Coatings of Steel Industrial Chain Link Fence Framework
- H. ASTM F1083 Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

1.4 SUBMITTALS

- A. Shop drawings: Site plan showing layout of fence location with dimensions, location of gates and opening size, cleared area, elevation of fence, gates, footings and details of attachments. Comply with the provisions of Section 01 33 23.
- B. Material samples: When required, provide representative samples of chain link fabric, framework and fittings.

- C. Specification Changes: May not be made after the date of bid.

1.5 QUALITY ASSURANCE

- A. Manufacturer: Company having manufacturing facilities in the United States with 5 years experience specializing in manufacturing of chain link fence products.
- B. Fence contractor: Contractor having 5 years experience installing similar projects in accordance with ASTM F567.
- C. Tolerances: ASTM current specifications and tolerances apply and supersede any conflicting tolerance.
- D. Single source: To ensure system integrity obtain the chain link system, framework, fabric, fittings, gates and accessories from a single source.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Framework, posts, rails, fabric, and fittings for chain link fence system:

- 1. **MERCHANTS METALS®**

- www.merchantsmetals.com

- Phone: (888) 260-1600

- 2. **STEVENS PIPE & STEEL®**

- www.SPSFENCE.com

- Phone: (270) 866-3331

- 3. **MASTER HALCO®**

- www.MASTERHALCO.com

- Phone: (888) 643-3623

- 4. **Or Equivalent**

2.2 CHAIN LINK FABRIC

- A. Steel Chain Link Fabric: [Heights indicated on drawings] <Select from table below and insert ASTM serial designation, mesh size, wire gauge, coating specification, including class and color when applicable, top/bottom selvage >

- 1. Polymer Coated Steel Fabric: ASTM F668, wire gauge specified is that of the metallic coated steel core wire.

- a. Class 1 extruded

- b. Color - **BLACK** in compliance with ASTM F934.

- 2. Size and Height: Chain link fabric: 1-¾" mesh, 8 gauge, steel core wire.

2.3 ROUND STEEL PIPE FENCE FRAMEWORK

- A. Round steel pipe and rail: Cold-rolled electric-resistance welded pipe in accordance with ASTM F1043 Materials Design Group IC (**LG-40**), minimum steel yield strength 50,000 psi (344 MPa). Type B external coating, hot dip galvanized zinc 0.9 oz/ ft² (305 g/m²) with a clear polymeric overcoat, Type D interior 90% zinc-rich coating having a minimum thickness of 0.30 mils (0.0076 mm).

- 1. Line post: 2-½" OD

- 2. End, Corner, Pull post: 3" OD

3. Top, brace, bottom and intermediate rails: 1-5/8" OD

- B. Polymer Coated Pipe: Polymer coated pipe shall have a PVC coating fused and adhered to the exterior zinc coating of the galvanized pipe in accordance with ASTM F1043. The minimum thickness of the PVC coating shall be 10-mils (0.254 mm). Color to match fabric **BLACK** per ASTM F934.

Framework Wind Load Caution:

Fences containing windscreens or privacy slats and fences greater than 8 feet (2.4 m) in height using, 1 in. (25 mm) mesh or smaller - recommend a wind load force analysis for post selection and post spacing. See Chain Link Manufactures Institute – Wind Load Guide CLFMI: WLG 2445. A interactive Wind load Fence Post Calculator is available at www.wheatland.com]

2.4 TENSION WIRE

- A. Polymer Coated Steel Tension Wire: 7 gauge core (0.177 in.) (4.50 mm) wire complying with ASTM F1664. Match coating class and color to that of the chain link fabric.

2.5 FITTINGS

- A. Tension and Brace Bands: Galvanized pressed steel complying with ASTM F626, minimum steel thickness of 12 gauge (0.105 in.) (2.67 mm), minimum width of 3/4 in. (19 mm) and minimum zinc coating of 1.20 oz/ft² (366 g/m²). Secure bands with 5/16 in. (7.94 mm) galvanized steel carriage bolts.
- B. Terminal Post Caps, Line Post Loop Tops, Rail and Brace Ends, Boulevard Clamps, Rail Sleeves: In compliance to ASTM F626, pressed steel galvanized after fabrication having a minimum zinc coating of 1.20 oz/ft² (366 g/m²).
- C. Truss Rod Assembly: In compliance with ASTM F626, 3/8 in. (9.53 mm) or 5/16" (7.94 mm) diameter steel truss rod with a pressed steel tightener, minimum zinc coating of 1.2 oz/ft² (366 g/m²), assembly capable of withstanding a tension of 2,000 lbs. (970 kg).
- D. Tension Bars: In compliance with ASTM F626. Galvanized steel one-piece length 2 in. (50 mm) less than the fabric height. Minimum zinc coating 1.2 oz. /ft² (366 g/m²).
- F. Polymer Coated Color Fittings: In compliance with ASTM F626, minimum coating thickness 0.006 in. (0.152 mm) fused and adhered to the zinc coated fittings.

2.6 TIE WIRE and HOG RINGS

- A. Basic commercial / industrial applications - 9 gauge core aluminum alloy ties and hog rings per ASTM F626.
- B. Added security or fence containing privacy slats 9 gauge core (0.148) (3.76 mm) steel Galvanized Before Weave (GBW) with preformed power fastened wire ties and preformed hog rings having minimum zinc coating 1.20 oz/ft² (366 g/m²) per ASTM F626.
- C. Polymer coated, match the coating, class and color to that of the chain link fabric

2.7 SWING GATES

- A. Swing Gates: Galvanized steel pipe welded fabrication in compliance with ASTM F900. Gate frame members 1.900 in. OD (48.3 mm) ASTM F1043 Group IC (**LG-40**) galvanized steel pipe. Frame members spaced no greater than 8 ft. (2440 mm) apart

vertically and horizontally. Welded joints protected by applying zinc-rich paint in accordance with ASTM Practice A780. Positive locking gate latch, pressed steel galvanized after fabrication. Galvanized malleable iron or heavy gauge pressed steel post and frame hinges. Provide lockable drop bar and gate holdbacks with double gates. Match gate fabric to that of the fence system. Gateposts per ASTM F1083 schedule 40 galvanized steel pipe, match the coating type and color to that specified for the fence framework. Moveable parts such as hinges, latches and drop rods may be field coated using a liquid polymer touch up.

B. Gateposts: Regular Grade ASTM F1083 Schedule 40 pipe

2.8 CONCRETE

Concrete for post footings shall have a 28-day compressive strength of 3,000 psi. (17.2 MPa).

PART 3 EXECUTION

3.1 CLEARING FENCE LINE

Clearing: Surveying, clearing, grubbing, grading and removal of debris for the fence line or any required clear areas adjacent to the fence are specified in contract documents. The contract drawings indicate the extent of the area to be cleared and grubbed.

3.2 FRAMEWORK INSTALLATION

- A. Posts: Posts shall be set plumb in concrete footings in accordance with ASTM F567. Minimum footing depth, 24 in. (609.6 mm) plus an additional 3 in. (76.2 mm) depth for each 1 ft. (305 mm) increase in the fence height over 4 ft. (1220 mm). Minimum footing diameter four times the largest cross section of the post up to a 4.00" (101.6 mm) dimension and three times the largest cross section of post greater than a 4.00" (101.6 mm) dimension. **Local codes, site soil conditions, local frost depth, fence height and wind load may require larger diameter or deeper footings - See Chain Link Manufactures Institute – Product Guide and Wind Load Guide CLFMI: WLG 2445.** Top of concrete footing to be at grade crowned to shed water away from the post. Line posts installed at intervals not exceeding 10 ft. (3.05 m) on center.
- B. Top rail: When specified, install 21 ft. (6.4 m) lengths of rail continuous thru the line post or barb arm loop top. Splice rail using top rail sleeves minimum 6 in. (152 mm) long. Rail shall be secured to the terminal post by a brace band and rail end. Bottom rail or intermediate rail shall be field cut and secured to the line posts using boulevard clamps or brace band with rail end.
- C. Terminal posts: End, corner, pull and gate posts shall be braced and trussed for fence 6 ft. (1.8 m) and higher and for fences 5 ft. (1.5 m) in height not having a top rail. The horizontal brace rail and diagonal truss rod shall be installed in accordance with ASTM F567.
- D. Tension wire: Shall be installed 4 in. (101.6 mm) up from the bottom of the fabric. Fences without top rail shall have a tension wire installed 4 in. (101.6 mm) down from the top of the fabric. Tension wire to be stretched taut, independently and prior to the fabric, between the terminal posts and secured to the terminal post using a brace band. Secure the tension wire to each line post with a tie wire. <Install the top tension wire through the barb arm loop for fences having barbed wire and no top rail.>

3.3 CHAIN LINK FABRIC INSTALLATION

Chain Link Fabric: Install fabric to security side of the framework maintaining a ground clearance of no more than 2 inches (50 mm). Attach fabric to the terminal post by threading the tension bar through the fabric; secure the tension bar to the terminal post with tension bands and 5/16 in. (7.94 mm) carriage bolts spaced no greater than 12 inches (304.8mm) on center. Small mesh fabric less than 1 in. (25 mm), attach to terminal post by sandwiching the mesh between the post and a vertical 2 in. wide (50mm) by 3/16 in. (4.76 mm) galvanized steel strap using carriage bolts, bolted thru the bar, mesh and post spaced 15 in. (381 mm) on center. Chain link fabric to be stretched taut free of sag. Fabric to be secured to the line post with tie wires spaced no greater than 12 inches (304.8 mm) on center and to horizontal rail spaced no greater than 18 inches (457.2 mm) on center. Secure the fabric to the tension wire by crimping hogs rings around a fabric wire picket and tension wire.

3.4 GATE INSTALLATION

- A. Swing Gates: Installation of swing gates and gateposts in compliance with ASTM F 567. Direction of swing shall be [inward or outward.] Gates shall be plumb in the closed position having a bottom clearance of 3 in. (76 mm), grade permitting. Hinge and latch offset opening space shall be no greater than 3 in. (76 mm) in the closed position. Double gate drop bar receivers shall be set in a concrete footing minimum 6 in. (152 mm) diameter 24 in. (609.6 mm) deep. Gate leaf holdbacks shall be installed for all double gates. Electrically operated gates must be manufactured and installed in compliance with ASTM F2200 and UL 325.
- B. Horizontal Slide Gates: Install according to manufacturer's instructions and in accordance with ASTM F567. Gates shall be plum in the closed position, installed to slide with an initial pull force no greater than 40 lbs. (18.14 kg). Double gate drop bar receivers to be installed in a concrete footing as required by site conditions and codes. Ground clearance shall be 3 in. (76 mm), grade permitting. Electrically operated gate installation must conform to ASTM F2200 and UL 325.

3.5 NUTS AND BOLTS

Bolts: Carriage bolts used for fittings shall be installed with the head on the secure side of the fence. All bolts shall be peened over to prevent removal of the nut.

3.6 ELECTRICAL GROUNDING

Grounding: Grounding of the fence and gates is not the responsibility of the fence contractor and not included in the fencing scope of work for this contract. Grounding, when required, shall be specified and included in Contract Section 33 79 00 Site Grounding. A licensed electrical contractor shall install grounding when required.

3.7 CLEAN UP

Clean Up: The area of the fence line shall be left neat and free of any debris caused by the installation of the fence.

END OF SECTION 32 31 13

SECTION 330500
EXCAVATING, BACKFILL, AND COMPACTING FOR UTILITIES

1. **GENERAL**

1.01 SUMMARY

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division One Specification sections, apply to work of this section.

1.02 DESCRIPTION

- A. The work of this Section includes all necessary labor, materials and equipment required to properly control the compaction of backfill materials as detailed on the drawings and outlined herein.

1.03 RELATED WORKS SPECIFIED ELSEWHERE

- A. Site Clearing
- B. Excavating, Backfilling & Compacting for Utilities

1.04 TESTING AGENCY

- 1. Geotechnical engineering firm approved by project engineer.
- 2. Tests on material for controlled fill shall be paid by Contractor.

1.05 REFERENCE STANDARDS

- 1. American Society for Testing Materials (ASTM).
 - a. ASTM D 698, Standard Proctor Compaction

- 1.06 Testing laboratory reports stating that materials for controlled fill meet requirements of this Section.

- 1.07 Provide Architect with one (1) copy of test reports. Provide General Contractor with two (2) copies of test reports.

- 1.08 Accomplish testing in accordance with ASTM requirements relative to environmental conditions.

2. **MATERIALS**

2.01 CRUSHED LIMESTONE

- A. Minimum densities: Provide one test for every 2,000 sq. ft. of building area

3. EXECUTION

- 3.01 Inspect surfaces to receive fill for defects which may affect execution of work such as deleterious material or soft, boggy spots.
- 3.02 Do not commence compaction of fill materials until all defects are corrected.
- 3.03 Compact materials uniformly and evenly to required subgrade elevations.
- 3.04 EQUIPMENT
 - A. Vibratory roller or pneumatic tampers as recommended by Architect/Soils Engineer.
 - B. Sandy materials: Pneumatic wheel rollers, or as recommended by Architect/Soils Engineer.

END OF SECTION 312020

SECTION 331000
WATER UTILITIES

PART 1 GENERAL

1.1 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of piping mains, valves, connections, and invert elevations.
- B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.2 QUALITY ASSURANCE

- A. Perform Work in accordance with utility company requirements.

PART 2 PRODUCTS

2.1 PIPE (utilize types of pipe as allowed by local code and as indicated on Drawings)

- A. Ductile Iron Pipe: AWWA C150
 - 1. Fittings: Ductile iron, standard thickness.
 - 2. Joints: ANSI/AWWA C111, rubber gasket with rods.
 - 3. Jackets: ANSI/AWWA C105 polyethylene jacket.
- B. Copper Tubing: ASTM B88, Type L, annealed:
 - 1. Fittings: ANSI/ASME B16.18, cast copper, or ANSI/ASME B16.22, wrought copper.
 - 2. Joints: Compression connection or ANSI/AWS A5.8, BCuP silver braze.
- C. PVC Pipe: AWWA C900 Class 150 (DR-18) except that lines serving fire sprinkler systems must be AWWA C900 class 200 (DR14):
 - 1. Fittings: AWWA C110, ductile or gray iron.
 - 2. Joints: ASTM D 3139 compression gasket ring.
 - 3. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Water Service" in large letters.

2.2 GATE VALVES - Up to 3 Inches:

- A. Brass or Bronze body, non-rising stem, inside screw, single wedge or disc, compression ends, with control rod, extension box and valve key.

2.3 GATE VALVES - 3 Inches and Over

- A. ANSI/AWWA C500, Iron body, bronze trim, non-rising stem with square nut, single wedge, flanged ends, control rod, extension box and valve key.
- B. ANSI/AWWA C509, Iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, [flanged] [mechanical joint] ends, control rod, [post indicator,] extension box [and valve key].

.4 BALL VALVES - Up to 2 Inches

- A. Brass body, teflon coated brass ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, AWWA compression inlet end, compression outlet, with control rod, extension box and valve key.

2.5 SWING CHECK VALVES - From 2 inches to 24 inches

- A. ANSI/AWWA C508, iron body, bronze trim, 45 degree swing disc, renewable disc and seat, flanged ends.

2.6 BUTTERFLY VALVES - From 2 inches to 24 inches

- A. ANSI/AWWA C504, iron body, bronze disc, resilient replaceable seat, water or lug ends, infinite position lever handle.

2.7 FIRE HYDRANT

- A. Hydrant: Type as required by authorities having jurisdiction.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends and remove burrs.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare pipe connections to equipment with flanges or unions.

3.2 BEDDING

- A. Excavate pipe trench and hand trim excavation for accurate placement of pipe to elevations indicated.
- B. Place bedding material at trench bottom, level fill materials in one continuous layer.
- C. Backfill around sides and to top of pipe with fill, tamped in place and compacted.
- D. Maintain optimum moisture content of bedding material to attain required compaction density.

3.3 INSTALLATION - PIPE

- A. Maintain separation of water main from sewer piping in accordance with code requirements.
- B. Install ductile iron piping and fittings to ANSI/AWWA C600.
- C. Route pipe in straight line.
- D. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- E. Install access fittings to permit disinfection of water system performed under Section 02511.
- F. Slope water pipe and position drain at low points.
- G. Form and place concrete for thrust blocks at each elbow or change of direction of pipe main.

3.4 INSTALLATION - VALVES AND HYDRANTS

- A. Set valves on solid bearing.
- B. Center and plumb valve box over valve. Set box cover flush with finished grade.
- C. Set hydrants plumb and locate pumper nozzle perpendicular to roadway.

D. Set hydrants to grade, with nozzles at least 20 inches above ground.

3.5 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Flush and disinfect system in accordance with Section 02511.

3.6 SERVICE CONNECTIONS

A. Provide water service to utility company requirements with reduced pressure back-flow preventer and water meter with by-pass valves.

END OF SECTION 331000

SECTION 333000
SANITARY SEWERAGE UTILITIES

1. **GENERAL**

1.01 WORK INCLUDED

The Contractor shall furnish all labor, material, and equipment necessary to install gravity sewer piping together with all appurtenances as shown and detailed on the Drawings and specified herein.

1.02 RELATED WORK

- A. Excavating, Backfilling and Compacting Utilities
- B. Manholes and Precast Sewage Structures

2. **PRODUCTS**

2.01 PIPE AND FITTINGS

A. Polyvinyl Chloride (PVC) Pipe

1. Solid Wall PVC Pipe (SDR 35):

- a. PVC pipe and fittings less than 15 inches in diameter shall conform to the requirements of ASTM Standard Specifications for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings, Designation D 304. Pipe and fittings shall have a minimum cell classification of 12454B or 12454C as defined ASTM D-1784. All pipe shall have a pipe diameter to wall thickness ratio (SDR) of a maximum of 35.
- b. PVC pipe and fitting with diameters 18 inch through 27 inch shall conform to the requirements of ASTM D-1784 and ASTM F-679. Pipe and fittings shall have a minimum cell classification of 12454C. The minimum wall thickness shall conform to T-1 as specified in ASTM F-679.
- c. Joints shall be push-on bell and spigot type using elastomeric ring gaskets conforming to ASTM D 3212 F 477. The gaskets shall be securely fixed into place in the bells so that they cannot be dislodged during joint assembly. The gaskets shall be of a composition and texture which is resistant to common ingredients of sewage and industrial wastes, including oils and groundwater, and which will endure permanently under the conditions of the proposed use.
- d. Pipe shall be furnished in lengths of not more than 14 feet. The centerline of each pipe section shall not deviate from a straight

line drawn between the centers of the opening at the ends by more than 1/16 inch per foot of length.

- e. PVC pipe shall not have a filler content greater than ten percent (10%) by weight relative to PVC resin in the compound.
- f. PVC pipe shall be clearly marked at intervals of 5 feet or less with the manufacturer's name or trademark, nominal pipe size, PVC cell classification, the legend "Type PSM SDR 35 PVC Sewer Pipe" and the designation "ASTM D 3034", or "ASTM F-679". Fittings shall be clearly marked with the manufacturer's name or trademark, nominal size, the material designation "PVC, "PSM" and the designation "ASTM D 3034", or "ASTM F-679".
- g. PVC pipe shall have a minimum pipe stiffness of 46 psi for each diameter when measured at 5 percent vertical ring deflection and tested in accordance with ASTM D-2412.
- h. Five (5) copies of directions for handling and installing the pipe shall be furnished to the Contractor by the manufacturer at the first delivery of pipe to the job. PVC pipe installation shall conform to ASTM D-2321 latest revision.
- i. Pipe shall be as manufactured by J&M Pipe Company, or equivalent.

3. EXECUTION

3.01 PIPE LAYING

- A. All pipe shall be laid with ends abutting and true to the lines and grades indicated on the Drawings. The pipe shall be laid straight between changes in alignment and at uniform grade between changes in grade. Pipe shall be fitted and matched so that when laid in the trench, it will provide a smooth and uniform invert. Supporting of pipe shall be as set out in Section 312333 and in no case shall the supporting of pipe on blocks be permitted.
- B. Before each piece of pipe is lowered into the trench, it shall be thoroughly swabbed out to insure its being clean. Any piece of pipe or fitting which is known to be defective shall not be laid or placed in the lines. If any defective pipe or fitting shall be discovered after the pipe is laid, it shall be removed and replaced with a satisfactory pipe or fitting without additional charge. In case a length of pipe is cut to fit in a line, it shall be so cut as to leave a smooth end at right angles to the longitudinal axis of the pipe and beveled to match factory bevel for insertion into gasketed joints. Bevel can be made with hand or power tools.
- C. The interior of the pipe, as the work progresses, shall be cleaned of dirt, jointing materials, and superfluous materials of every description. When laying of pipe is stopped for any reason, the exposed end of such pipe shall be closed with a

plywood plug fitted into the pipe bell so as to exclude earth or other material and precautions taken to prevent flotation of pipe by runoff into trench.

- D. All pipe shall be laid starting at the lowest point and installed so that the spigot ends point in the direction of flow.

3.02 JOINTING

All joint surfaces shall be cleaned immediately before jointing the pipe. The bell or groove shall be lubricated in accordance with the manufacturer's recommendation. Each pipe unit shall then be carefully pushed into place without damage to pipe or gasket. All pipe shall be provided with home marks to insure proper gasket seating. Details of gasket installation and joint assembly shall follow the direction of the manufacturer's of the joint material and of the pipe. The resulting joints shall be watertight and flexible. No solvent cement joints shall be allowed.

3.03 WATER PIPE CROSSING CONCRETE ENCASEMENT

- A. At locations shown on the Drawings, required by the Specifications, or as directed by the Engineer, concrete encasement shall be used when the clearance between the proposed sewer pipe and any existing or proposed water pipe is 18 inches or less.
- B. Whether the proposed sewer pipe is above or below the water pipe, the concrete shall fully encase the sewer pipe and extend to the spring line of the water pipe. Encasement shall extend in each direction along the sewer pipe until the encased sewer pipe is 10 feet from the water pipe, measured perpendicular to the water pipe.
- C. Concrete shall be 3000 psi and shall be mixed sufficiently wet to permit it to flow between and under pipes to form a continuous bridge. In tamping the concrete, care shall be taken not to disturb the grade or line of either pipe or damage the joints.
- D. Concrete for this Work is not a separate pay item and will be considered incidental to sewer pipe installation.

3.04 TESTING OF GRAVITY SEWER LINES

- A. After the gravity piping system has been brought to completion, and prior to final inspection, the Contractor shall rod out the entire system by pushing through each individual line in the system, from manhole to manhole, appropriate tools for the removal from the line of any and dirt, debris, and trash. If necessary during the process of rodding the system, water shall be turned into the system in such quantities to carry of the dirt, debris, and trash.
- B. During the final inspection, the Engineer will require all flexible sanitary sewer pipe to be mandrel deflection tested after installation.

1. The mandrel (go/no-go) device shall be cylindrical in shape and constructed with nine (9) evenly spaced arms of prongs. The mandrel dimension shall be 95 percent of the flexible pipe's published ASTM average inside diameter. Allowances for pipe wall thickness tolerances of ovality (from shipment, heat, shipping loads, poor production, etc.) shall not be deducted from the ASTM average inside diameter, but shall be counted as part of the 5 percent allowance. The contact length of the mandrel's arms shall equivalent or exceed the nominal diameter of the sewer to be inspected. Critical mandrel dimensions shall carry a tolerance ± 0.001 inch.
 2. The mandrel inspection shall be conducted no earlier than 30 days after reaching final trench backfill grade provided, in the opinion of the Engineer, sufficient water densification or rainfall has occurred to thoroughly settle the soil throughout the entire trench depth. Short-term (tested 30 days after installation) deflection shall not exceed 5 percent of the pipe's average inside diameter. The mandrel shall be hand pulled by the contractor through all sewer lines. Any sections of the sewer not passing the mandrel test shall be uncovered and the Contractor shall replace and recompact the embedment backfill material to the satisfaction of the Engineer. These repaired sections shall be retested with the go/no-go mandrel until passing.
 3. The Engineer shall be responsible for approving the mandrel. Proving rings may be used to assist in this. Drawings of the mandrel with complete dimensioning shall be furnished by the Contractor to the Engineer for each diameter and type of flexible pipe.
- C. The pipe line shall be made as nearly watertight as practicable, and leakage tests and measurements shall be made. All apparatus and equipment for testing shall be furnished by the Contractor and the cost shall be included in the unit price bid for pipe and manholes.
1. The Engineer may require the Contractor to smoke test the first section (manhole to manhole) of each size of pipe and type of joint prior to backfilling, to establish and check laying and jointing procedures. The test shall consist of smoke blown into closed-off sections of sewer under pressure and observing any smoke coming from the pipe line indicating the presence of leaks. Other supplementary smoke test prior to backfilling may be performed by the Contractor at his option; however, any such tests shall not supplant the final tests of the completed work unless such final tests are waived by the Engineer.
 2. Where the groundwater level is more than 1 foot above the top of the pipe at its upper end, the Contractor shall conduct either infiltration tests or low pressure air tests on the completed pipeline.
 3. Where the groundwater level is less than 1 foot above the top of the pipe at its upper end, the Contractor shall conduct either exfiltration tests or low pressure air tests on the completed pipeline.

D. Low pressure air tests shall be made using equipment specifically designed and manufactured for the purpose of testing sewer lines using low pressure air. The equipment shall be provided with an air regulator valve or air safety valve so set that the internal pressure in the pipeline cannot exceed 8 psig.

1. The test shall be made on each manhole-to-manhole section of pipeline after placement of the backfill. The Engineer or his designated representative must be present to witness each satisfactory air test before it will be accepted as fulfilling the requirements of these Specifications.
2. Pneumatic plugs shall have a sealing length equivalent to or greater than the diameter of the pipe to be tested. Pneumatic plugs shall resist internal test pressures without requiring external bracing or blocking.
3. Low pressure air passing through a single control panel, shall be introduced into the sealed line until the internal air pressure reaches 4 psig greater than the maximum pressure exerted by groundwater that may be above the invert of the pipe at the time of test. However, the internal air pressure in the sealed line shall not be allowed to exceed 8 psig. When the maximum pressure exerted by the groundwater is greater than 4 psig, the Contractor shall conduct only an infiltration test.
4. At least two minutes shall be allowed for the air pressure to stabilize in the section under test. After the stabilization period, the low-pressure air supply hose shall be quickly disconnected from control panel. The time required in minutes for the pressure in the section under test to decrease from 3.5 to 2.5 psig (greater than the maximum pressure exerted by groundwater that may be above the invert of the pipe) shall not be less than that shown in the following table:

Pipe in Diameter in Inches	Minutes
4	2.0
6	3.0
8	4.0
10	5.0
12	5.5
15	7.5
18	8.5
21	10.0
24	11.5

5. When the sewer section to be tested contains more than one size of pipe, the minimum allowable time shall be based on the largest diameter

pipe in the section, and shall be the time shown in the table reduced by 0.5 minutes.

6. Reinforced concrete pipe shall be tested in accordance with ASTM C 924 (joint testing shall be in accordance with ASTM C 1103). Test time shall be a function of pipe diameter and the length of installed line to be tested as provided in ASTM C924.
- E. Infiltration tests shall be made after under drains, if present, have plugged and other groundwater drainage has been stopped such that the ground water is permitted to return to its normal level insofar as practicable.
1. Upon completion of a section of the pipeline, the line shall be dewatered and a satisfactory test conducted to measure infiltration for at least 24 hours. The amount of infiltration, including manholes, tees and connections, shall not exceed 200 gallons per nominal inch diameter per mile of sewer per 24 hours.
- F. Exfiltration tests which subject the pipeline to an internal pressure, shall be made by plugging the pipe at the lower end and then filling the line and manholes with clean water to a height of 2 feet above the top of the sewer at its upper end. Where conditions between manholes may result in test pressures which would cause leakage at the plugs or stoppers in branches, provisions shall be made by suitable ties, braces and wedges to secure the plugs against leakage resulting from the test pressure.
1. The rate of leakage from the sewers shall be determined by measuring the amount of water required to maintain the level 2 feet above the top of the pipe.
 2. Leakage from the sewers under test shall not exceed the requirements for leakage into sewers as hereinbefore specified.
- G. The Contractor shall furnish suitable test plugs, water pumps, and appurtenances, and all labor required to properly conduct the tests. Suitable bulkheads shall be installed, as required, to permit the test of the sewer. The Contractor shall construct weirs or other means of measurements as may be necessary.
- H. Should the sections under test fail to meet the requirements, the Contractor shall do all work of locating and repairing the leaks and retesting as the Engineer may require without additional compensation.
- I. If in the judgment of the Engineer, it is impracticable to follow the foregoing procedures for any reason, modifications in the procedures shall be made as required and as acceptable to the Engineer, but in any event the Contractor shall be responsible for the ultimate tightness of the line within the above test requirements.

END OF SECTION 333000

SECTION 334000 - STORM DRAINAGE

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Suitable Storm Piping
2. Bedding Materials
3. Castings
4. Fittings for Corrugated Polyethylene Pipe.

1.2 SUBMITTALS:

- A. Contractor shall submit detailed dimensional drawing showing placement of reinforcement steel and manufacturer and dimension of castings for each precast structure provided.

PART 2 - PRODUCTS

2.1 SUITABLE STORM PIPING:

- A. Corrugated metal pipe with a smooth interior shall meet the requirements shown on the plans.
- B. Concrete Pipe shall be circular reinforced gasketed concrete pipe conforming to AASHTO M 170 (KYTC spec).
- C. Polypropylene Pipe shall have a smooth interior and annular exterior corrugations to meet ASTM F2881 or AASHTO M330.

2.2 BEDDING MATERIALS:

- A. Crushed stone for bedding shall meet coarse aggregate conforming to Size No. 57 as set forth in Section 805 of the Kentucky Transportation Cabinet Standard Specifications.
- B. Sand for backfilling shall be comprised of sand or sand-gravel mixtures containing less than 30 percent passing a No. 40 sieve and less than 5 percent passing a No. 200 sieve. Sand or sand gravel mixtures shall classify as SW, SP, or GW and shall have a uniformity coefficient of 4.5 or more as set forth in ASTM D 2487.

.3 CASTINGS:

- A. Casting shall meet the requirements of ASTM A-48 Standard Specification for Gray Iron Castings for Class No. 35-B, Gray Iron. Castings shall be manufactured by the Neenah Company, John Bouchard or equal.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. After the trench is excavated to subgrade, it shall be filled to grade with crushed stone to provide a firm satisfactory bed, for the entire length of sewer pipe barrel. Pipe of the designated class and size shall be laid to form a closed joint with the next adjoining pipe, bringing inverts to the required line and grade shown on the drawings. The pipe shall be laid in an upstream direction with the bell or grove end upstream, unless otherwise permitted or directed.
- B. If in the opinion of the Engineer the subgrade of the storm sewer or is not suited for the bedding of the sewer pipe, he may order the Contractor to use additional crushed stone or concrete to cradle the pipe. The amount of additional crushed stone or concrete required shall be determined by the Engineer.
- C. The Contractor shall be responsible for sheeting or bracing pipe trenches where necessary to provide adequate protection for workers and adjacent improvements.
- D. Backfill of trenches shall be completed as soon as possible after the pipe is placed. The Contractor shall utilize compacted excavated or imported materials.
 - 1. Within the limits of pavement backfill shall consist of crushed stone installed to limit of subgrade.
 - 2. Outside the limits of pavement backfill shall consist of select excavated materials mechanically compacted.
- F. All inline drains and the slotted drain shall be constructed in accordance with the details shown on the plans and at the elevation and location indicated or established.
- G. All storm drainage installations shall be in accordance with all applicable storm drainage rules and regulations of the Local Authority.

END OF SECTION